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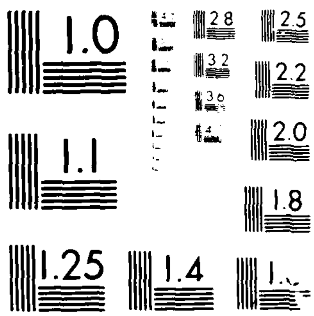
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FOUNDATION REPORT
STONEWALL JACKSON DAM
WESTON, WEST VIRGINIA

CONTRACT NO. DACW59-83-C-0053

VOLUME 1 OF 2

9

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The geology of the Stonewall Jackson dam site and a discussion of how the engineered structures were adapted to the existing rock conditions is the purpose of this report. Stonewall Jackson dam is located in central West Virginia near the town of Weston. Geologically, it is in the Kanawha Section of the Appalachian Plateau Provience and the Pennsylvanian Age rocks are mostly sandstones and shales. The principal feature of this contract was the construction of a 620-foot long, 95-foot high concrete gravity dam with a uncontrolled spillway. The rock excavation and geologic features for each of

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20. the monolithic foundations, along with the grouting program is discussed in detail. Rock excavation was by conventional drilling and blasting. A fault zone was uncovered in the foundation and had to be treated. All grout records were computerized and a detailed discussion of the program with examples is included.

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SECTION I

INTRODUCTION

1-01 PROJECT LOCATION AND DESCRIPTION - The Stonewall Jackson Lake Project is located in the West Fork River Basin section of Lewis County, West Virginia. The dam site, the major feature of this project, is located approximately 5 miles due south of Weston, West Virginia and 73 miles upstream from Fairmont, West Virginia, where the West Fork River joins the Tygart River to form the Monongahela River. Regional and general locations of the project are shown in the Appendix; Section 10-2.

The Stonewall Jackson Lake Project is a multiple-purpose water resource project with authorized purposes of flood control, water quality control, water supply and recreation. Statistical data concerning various features of the project are shown in the appendix; Section 10-1.

1-02 CONSTRUCTION AUTHORITY - The Stonewall Jackson Lake Project was authorized by Section 203, Title II - Flood Control, of the Flood Control Act of 1966, Public Law 89-789, as approved 07 November 1966 by the 89th Congress, second session.

1-03 PURPOSE OF REPORT - The purpose of this report is to insure the preservation, for future use, of the complete records of the foundation conditions encountered during construction and the methods used to adapt the structures to these conditions.

1-04 PROJECT HISTORY - The history of the Stonewall Jackson Lake Project would span a time period of approximately forty years between 1947, when exploratory exploration for an earth dam site selection was performed, and 1989, when construction of recreation facilities is scheduled for completion.

Since this report deals exclusively with the construction of the dam portion of the project, a listing of design memoranda and major construction contracts is presented in the Appendix 10-1 of this report for reference to information concerning other events or time periods related to this project.

1-05 SCOPE - The scope of this report covers the investigations, observations, and treatments that were relative to establishing sound foundations for the various structures erected for the Stonewall Jackson Dam built under Contract No. DACW59-83-C-0053.

1-06 CONTRACTOR-SUBCONTRACTORS - The prime contractor for the construction of the concrete gravity dam and associated features, Contract No. DACW59-83-C-0053, was a joint venture of J. F. Allen Company, Clarksburg, West Virginia and Wiley N. Jackson Company, Roanoke, Virginia. This contract was awarded on 02 September 1983. Description of work as described in the contract was to construct a concrete gravity dam with the principal features of: a concrete spillway section with spray walls; concrete abutments each side of the spillway section; a stilling basin with paved floors, end sill and training walls downstream of the spillway section; five sluiceways through the spillway section controlled by hydraulically operated sluice gates; a pre-stressed concrete service bridge across the spillway section; a pylon building on the left abutment for operation purposes; gate operating machinery, maintenance bulkheads, water quality gates and hoists, electrical system, plumbing system, sanitary facilities, heating and ventilating system, and other miscellaneous metal items; and, access road connection and appurtenant work.

1-07 CONTRACT SUPERVISION AND QUALITY CONTROL ORGANIZATION - This contract was performed under a contractor-supervised Quality Control Program with quality assurance being conducted through a Government Resident office at the construction site. This office was administrated by a Resident Engineer acting as a legal representative of the Contracting Officer, the Huntington District Engineer. The Resident Engineer's staff varied during the construction program depending upon the workload during a particular phase of construction. (See Appendix 10-1 for a partial list of personnel.)

SECTION II

FOUNDATION EXPLORATION

2-01 INVESTIGATIONS PRIOR TO CONSTRUCTION - Subsurface investigations began in 1947 for an earth and rock filled dam, side channel spillway, and outlet works. Seventeen 3-inch diameter core borings were drilled for the dam axis and fourteen shallow 3-inch diameter borings were drilled in three proposed borrow areas. In 1968, additional drilling was conducted to delineate the site for a concrete dam. At that time, twenty-nine 3-inch borings over several alignments were drilled. In 1969, a downstream site was selected for the dam and an additional five 3-inch diameter borings were drilled. In 1972, drilling of thirty-four test borings on the new site and twenty-one test borings for a proposed right bank access road was accomplished, including nine 6-inch diameter test borings for the detailed inspection of weak seams and determination of founding elevations. In 1978, an additional nine 6-inch diameter borings and three 3-inch diameter borings were obtained for an extensive rock testing program. In May 1979, twenty-one 3-inch diameter test borings were drilled for a left bank access road. A summary of the various design strength parameters and stability values for the above test borings can be found in Design Memorandum No. 9. In 1980, eighteen NXM test borings and two 6-inch borings were drilled in the dam area to confirm previous information and to gather additional information for design purposes. In 1981, the final pre-construction exploratory work was performed when seven NXM borings were drilled for foundation information to design the access road bridge which crosses the West Fork River. Logs for all of these borings were listed in the Plans For Construction of the Dam, Volume I: Geotechnical Drawings and Hydrographs: DACW59-83-C-0053.

2-02 INVESTIGATIONS DURING CONSTRUCTION - The contract for the construction of the dam specified that following the removal of the overburden but prior to rock excavation, 4-inch diameter exploratory core borings would be drilled at the dam site (Bid Item 67). The information obtained from these borings was used to confirm or adjust the tentative founding elevation given for the individual dam monoliths. The contract gave the specific location for eighteen such borings with the stipulation that additional core borings would be drilled if deemed necessary. The drilling for the 4-inch diameter core borings was performed by a subcontractor, Crown Pressure Grouting of Warrington, Pennsylvania.

The initial exploratory drilling was performed between the period of 17 January 1984 and 12 April 1984 during which, twenty-two 4-inch diameter exploratory borings were drilled. In addition to

the eighteen borings specified in the contract, four extra borings were drilled for tentative founding elevation information: two in the stilling basin area, and two in the Monolith 12/13 area.

After evaluation of the core samples obtained from these twenty-two borings by ORHCD, ORPED, ORD, and OCE personnel, the contractor was requested to drill an additional five 4-inch diameter core borings in the Monoliths 12/13 area for additional information needed before selecting a final grade for these monoliths. The subcontractor returned to the job site and completed these five borings between 17 September 1984 and 11 October 1984.

Equipment and procedures for drilling all the above 4-inch diameter exploratory core borings were as follows:

(1) Ater the overburden had been removed, the contractor would use a Davey Air Drill to drill the non-coring portion of an exploratory boring. The hole was drilled from top of rock to the specified elevation where core sampling was to commence by a 6-1/4 inch diameter tricone rock bit. After the hole was drilled to required depth, 6-inch casing (PVC pipe) was inserted into the hole.

(2) The subcontractor would move his drill, a model 40 Sprague and Henwood skid rig, onto the hole and core drill to required depth. The core samples were obtained by using a double tube, 4 by 5 inch core barrel with a diamond impregnated coring bit. After completion, the hole was backfilled with tremie grout.

When the rock in Monolith 12 had been excavated to tentative founding (elev. 985), inspection of the foundation produced concern about the generally poor foundation condition resulting from a fault that transversed the monolith's floor. It was decided by ORPED and ORD personnel that additional core drilling was necessary before a decision on the final founding elevation for Monolith 12 could be given. During the period 10 May 1985 to 14 May 1985, subcontractor, H. B. Mott and Sons, drilled five 6-inch diametered borings in Monolith 12. After review of the core samples, the founding elevation 985 was agreed as acceptable for Monolith 12.

In conclusion, there were twenty-seven 4-inch diametered and five 6-inch diametered core borings drilled during the construction of the Stonewall Jackson Dam.

The location, drilling logs, and statistical data of all exploratory borings drilled during construction are listed in the Appendix of this report.

SECTION III

GEOLOGY

3-01 REGIONAL GEOLOGY - The Stonewall Jackson Lake Project is located in the southern portion of the West Fork River Basin that is being developed in the gently folded, highly dissected Kanawha Section of the Appalachian Plateaus. The regional drainage pattern is predominantly dentritic with submature developed topography characterized by narrow ridges, steep valley slopes and limited flood plain development along the streams. From the basin divide to the dam site, there is a relief of about 800 feet exposing the upper part of the Allegheny Formation, all of the Conemaugh and Monongahela formations of the Pennsylvania System and the Basal Dunkard formation of the Permian System.

Major structureal features within this 843 square mile river basin are the Wolf Summit, Chestnut Ridge and Orlando anticlines and the Shinnston, Grassland, Robinson, and Roanoke synclines. See Appendix 10-2 for Regional Geologic Maps.

3-02 SITE GEOLOGY - The elevation of the West Fork River at the dam site before construction was 1015 feet (m.s.l.). The soil cover at the dam site consisted of lean clays and sandy silts, with varying amounts of rock fragments. Soil thickness at the site was relatively thin, ranging from five to thirty feet with the flood plain having the thickest cover over bedrock in the form of a mixtrue of alluvial and colluvial deposits.

3-02.1 BEDROCK STRUCTURE - The attitude of the bedrock at the dam site is the resultant of three factors. First, and most prominent, is the approximately five percent regional dip, from the right abutment to the left abutment, towards the axis of the Roanoke syncline located about 0.4 miles west of the dam site. Second is the general flattening across the river valley floor resulting from the rock structure rebound due to stress relief that occurs with unloading by erosion. Thirdly is the variable inclinations associated with localized, minor warping of the bedrock.

The thin to massive bedded, sedimentary rocks at the dam site reacted relatively typical to the above activities. That is, under a long period of stress, the fine grained rocks (claystones and siltstones) conform elastically where as those units that had a sandy matrix, and thus more rigid, tend to fail. The resultant joint and fracture pattern were observed during rock excavation in almost every sandy formation encountered. These patterns ranged from close to medium spaced with variable orientation. See individual dam monolith and appurtenances details section, for

specific orientations. Also, relative to stream valley development, sheet jointing was prevalent near the rock surface of the sandy members that were located in both abutments.

One bedrock structure feature that was predominant throughout the rock excavation area was evidence of shearing along bedding planes. This was especially noticeable when there was a sharp contrast in material composition of adjacent beds (especially sandstone/claystone). Basically, these shear zones dictated the final founding elevation of the individual monoliths.

Two notable, vertical displacement faults were uncovered during the dam monolith's excavation. The first, a normal fault located in the Monolith 2 area, and the second, a reverse thrust fault located in the Monoliths 11/12 area.

The normal fault observed in the Monolith 2 foundation has a N 30 degress E strike and a dip of approximately 50 degrees towards the northwest. This fault has a displacement of approximately 6.5 feet and apparently resulting from pre-Pennsylvania Period activity since the overlying younger beds were not affected and thus probably deposited after the faulting had occurred.

The fault located in the Monoliths 11/12 excavated area is a N 10 degrees E striking, reverse thrust fault with a 25 degrees to 30 degrees dip towards the northwest. This fault and the previously noted horizontal bedding plane shearing are probably resultants of the post-Pennsylvania activities that produced most of the major structural features in this region. The fault gouge in the reverse thrust fault zone ranged in thickness from a few inches to approximately two feet, consisting of small, angular, slickensided rock fragments embedded in a clayey matrix. During excavation, moderate water flow (20-30 g.p.m.) was encountered in the fault related fractured zone, and occasionally, recementation had occurred in the rocks adjoining the fault zone. The source of this water is apparently from beneath the left abutment and is not directly connected to the West Fork River since, during periods of high water, there was no noticeable discoloration or increase in flow of the water inside the excavated area. Additional details relating to bedrock structure can be found in the individual monolith foundation sketches located in Appendix 10-2, and the photograph section (Volume II) of this report.

3-02.02 <u>BEDROCK WEATHERING</u> - The topography of the West Fork River Basin is the result of differential weathering of the rocks with structural controlled orientation.

At the dam site, the bedrock weathering was relatively shallow due to the fine grain texture and solubility resistant cementation characteristic of the rocks involved. However, in the abutments, the depth of weathering was more variable due to the staining and weathering that is associated with fractures in the rocks.

3-02.03 LEACHING AND/OR SOLUTION ACTIVITY - Due to the absence of carbonate rocks in the dam excavation area, leaching and solutioning activity was minimal. Leaching and/or staining was most notable in the water bearing fractured zones of the Redstone Coal seam and the occasional, near horizontal, shearing bedding contacts. The most notable result of solutioning were the secondary features produced from either weathering or recementation in the faulted zone in Monoliths 11/12 and the joint patterns in the bedrocks throughout the excavation.

3-02.04 GROUNDWATER - The water table in the area of the dam site is controlled by a series of perched tables separated by impervious zones of shales and indurated clays. Due to relative impervious nature of the bedrocks associated with excavation for the dam, the quantity of groundwater encountered was basically negligible and its movement structurally (joints and faults) controlled.

The majority of the groundwater encountered during dam construction was during the second stage excavation and directly associated with the faulted zone in Monoliths 11 and 12. In this instance, the only time special dewatering technique was necessary, the fault plane and the associated, adjacent fractured rocks were acting as a percolation path from a water source apparently located deep beneath the left abutment (see Monolith 12 foundation sketch for dewatering details). Second in quantity, and another structural related path for groundwater travel, was the near horizontal slip faulted bedding plane at approximate elevation 990. The quantity of water associated with this feature was minor and isolated to occasional piping zones due to the impervious nature of the fault gouge. The third source of groundwater, and very minor, was through the fractured Redstone Coal seam. However, the quantity of water related to this source was negligible compared to the overall total that was encountered during excavation.

3-03 ENGINEERING CHARACTERISTICS OF THE OVERBURDEN MATERIALS - The engineering characteristics of the overburden material were not essential on this project since the dam design was for a concrete structure. Most of the overburden material removed during excavation for the dam site was placed in two designated spoil areas, located upstream of the dam site. A small quantity of impervious material was stockpiled and later used as the core for the first stage cofferdams and as an impervious plug placed between Monolith 16 and the sloped rock surface of the left abutment.

3-04 ENGINEERING CHARACTERISTICS OF THE BEDROCK MATERIAL - In

1978, representative rock samples from 6-inch borings were tested by the Missouri River Division Laboratory in Omaha, Nebraska. Testing consisted of direct shear and unconfined compression strength test and determination of index properties for the rock that underlie the foundation for the concrete monoliths of the dam. These test results and a summary of the various design strength parameters and stability values used can be found in the Design Memorandum No. 9.

Due to the lack of durability, most of the rock that was produced from the excavation of the dam was unsuitable for the contract's permanent features, and thus, was either placed in a designated spoil area or used in constructing temporary features such as the cofferdams and haulroads. The rock that was required for the designed rock protection, riprap and stone gutters was obtained from a sandstone quarry located immediately upstream from the dam site. See Section 10-2 for location of quarry and spoil area.

Material for the concrete aggregate was obtained from a quarry in the Greenbrier Limestone Formation located in Elkins, West Virginia and delivered to the job site via trucks.

SECTION IV

SPECIAL DESIGN CONSIDERATIONS

4-01 LEFT ABUTMENT SLOPE STABILIZATION - Though performed under a separate contract, the slope stabilization on the left abutment above the dam was an integral part of the construction program for the Stonewall Jackson Dam. Data obtained from pre-construction exploratory borings of the left abutment indicated that the overburden consisted of colluvial material that had a high water table and a maximum thickness of about 40 feet. Since it would be necessary to cut into the toe of a lobe of this marginally stable material in order to construct the parking area located on the dam's left abutment beyond Monolith 16 and the safety factor involved with the diversion excavation during Stage I for dam construction, it was decided that slope stabilization was required.

4-01.01 DESIGN - To prevent probable sliding of this lobe onto the parking areas, it was considered necessary to remove the upper portion of the lobe and to support the remaining portion with a rockfill buttress. In order for the buttress to function as designed, the fill was required to be composed of hard, durable rock, be reasonably well compacted, and to be founded on a sound rock surface. So as not to interfere with the main function of the Stage I diversion channel, construction of the rock buttress was required to be completed prior to starting Stage I diversion.

4-01.02 CONSTRUCTION - Due to the timing factor involved, the construction of the rock fill buttress was incorporated into the Dam Access Road Contract (DACW59-82-C-0095). This contract was awarded to Alan Stone Company of Chesterhill, Ohio on 29 September 1982 with a scheduled completion date of 19 December 1983.

The construction of the buttress was to be performed in stages so as to minimize the potential for sliding of the overburden along the highly weathered rock zone below the overburden soil. It was essential that the buttress rest on and be keyed into a competent rock surface. From the available boring information, a layer of claystone existed at the approximate top of rock lines beneath the designed location of the buttress. Since it was undesirable for the buttress to rest on this material, the intent of the purposed 90 feet long by 40 feet wide rock cut was to expose a more competent siltstone or sandstone surface and to allow the buttress to be oriented to a more stable configuration.

When top of rock was exposed during excavation (Stage 2), it was discovered that the depth of overburden (max. 40 feet) had been distorted by the fact that some borings had been located in a filled, narrow channel running through a silty sandstone caprock.

After re-evaluation, the required stage construction for the rock buttress was adjusted to satisfy existing conditions. The sandstone rock used in the buttress was obtained from a small quarry located approximately one-quarter mile upstream of the dam site. Because of existing conditions, the amount of rock necessary to construct the buttress was reduced from the estimated quantity of 5,700 cubic yards to the actually placed quantity of 4,725 cubic yards.

4-01.03 INSTRUMENTATION - Instrumentation for this contract consisted of:

(a) Temporary Alignment Monuments - Both horizontal and vertical pins used to monitor the buttress during dam construction.

(b) Permanent Alignment Pins - Both horizontal and vertical pins used to monitor the buttress during dam construction.

(c) Inclinometers - Installed to monitor soil movement. Because of overburden movement, these monitors became inoperable within six months of installation.

4-01.04 COMMENT - The burden unloading and construction of a rock buttress on the left abutment served its designed safety function for the dam construction. However, during the time period spanning the dam construction, observation of continual cut slope failures and the opening of fissures higher on the left abutment indicates a rather extensive area of unstable overburden condition. At the time of this report, a study of this problem as it relates to the parking lot and the associated access road, is being conducted at the Pittsburgh District Office.

4-02 SEQUENCE OF DAM CONSTRUCTION - The Pittsburgh District Corps of Engineers designed the cofferdams and stipulated the sequence of work to be performed in excavating and erecting the Stonewall Jackson Dam. The following is a list of the contract's required two stage construction procedures with comments concerning "as built" modifications related to each sequence.

(1) Stage I (01 August 1983 - 21 December 1984)

(a) Excavate overburden for the diversion channel to the lines and slopes shown, include common excavation (overburden) for dam Monoliths 11 through 16. Install rockbolts for rock stabilization. Stockpile excavated materials which were suitable for cofferdams and backfill.

Comment: Work completed as specified except for the installation of rock bolts. The change in type of rock bolts used and the installation procedures is described in detail in Para. 4-03 -

"Rock Reinforcement".

(b) Construct the diversion channel as shown on the drawings. The contractor was to design and construct any temporary dikes which were required to complete the diversion channel. Excavated materials which were suitable for use in the cofferdams or fill were stockpiled.

Comment: After the diversion channel had been excavated, changes were made to the method of protecting the exposed rock surface of the channel from stream erosion and possible leakage into the coffered area. Design required that a specified portion of the exposed rock be sealed with concrete grout. However, due to the highly erodible nature of this rock surface, a 3-inch thick concrete pad was placed on the floor of the diversion channel and fibercrete was used in lieu of shotcrete to protect the channel walls. Also, the height of protection for the left wall was extended from elev. 1010 to elev. 1017 which was approximately river level under normal conditions. (See Section 10-2 for details.)

(c) After completion of the diversion channel, construct the closure dike portions of both the upstream and downstream cofferdams. Most of the dike placement was to be done in the wet. The dikes were to be placed to the slopes and crest elevation shown, and the rock protection was to be placed before the next item of work was started.

Comment: This work done as specified.

(d) After completion of the closure dikes, unwater the area between the dikes, and install dewatering systems as necessary to permit construction of the remainder of the upstream and downstream cofferdams and the floodway in the dry.

Comment: Dewatering was no problem. This was accomplished with one 6-inch and one 3-inch pump. A change was made to the design of the upstream cofferdam during construction which resulted in greater stability and a simpler placement procedure. Also, the emergency spillway, located in the downstream cofferdam was modified by a VECP proposal from a steel bearing beam and timber needle type structure to a culvert type (see Section 10-2 for details).

(e) After completion of Stage I diversion system, construct the permanent work within the diversion system (dam Monoliths 1 through 9 and stilling basin) to elevation 1082 (spillway crest), unless otherwise approved by the Contracting Officer. In no event would approval be given to completion of any monolith to less than elevation 1052 prior to removal of the Stage I cofferdam. Block slide gates in open position. Install 36-inch diameter penstock bulkhead.

Comment: Except for the lowering of several tentative founding elevations as a resultant from information obtained from the boring program, excavating and erecting dam Monolith 1 thru 9 and the stilling basin proceeded as designed. However, the monolith height requirements for this sequence was re-evaluated and changed when the contractor received approval for his VECP proposal to modify the Stage II diversion system.

(2) Stage II (07 January 1985 - 10 October 1985)

(a) After completion of permanent work to specified elevation within the Stage I diversion system, construct the Stage II downstream cofferdam, breach and remove Stage I cofferdams, complete construction of Stage II cofferdams, divert the river flow through the completed dam flood control sluice.

Comment: The specified sequences for cofferdam construction and diversion for Stage II were drastically revised when the contractor's VECP proposal to modify the Stage II diversion system was accepted (see dwgs. in Section 10-2).

(b) After completion of Stage II diversion system, construction the permanent work within the cofferdam area in the dry.

Comment: Work completed as specified with again variations to the tentative founding elevations for Monoliths 10 thru 16 resulting from information derived from the exploratory drilling program.

(c) After completion of the permanent work, the Stage II upstream cofferdam shall be incorporated in the final backfilling and grading.

Comment: This work was completed as it applied to the Stage II diversion modification guidelines with diversion of the West Fork River through the dam sluices being made on 10 October 1985. (See Section 10-1 for construction progress by dates.)

4-03 <u>ROCK REINFORCEMENT</u> FOR <u>STAGE</u> I <u>DIVERSION</u> - The rock between the Stage I diversion channel and the monolith excavation was reinforced with tensioned rock bolts as a stability precaution. The contract specified that mechanically anchored rock bolts (Willaims R1S Super-High Tensile bolts or equal) were to be used for this program, installed in a systematic pattern and tensioned to 155,000 pounds.

The contractor requested to use prestressed dywidag bars with bonding resin in lieu of the mechanical type anchors. Between 24 August 1983 and 01 September 1983, field tests were performed using both types of anchors. Both types failed to achieve the 155 kips tension requirement with poor rock conditions believed to be the reason for failure.

On 14 September 1983, a meeting was held at the Pittsburgh District Corps of Engineer's office to discuss the rock bolt test results. Decisions derived at this meeting were: (1) grouted anchors could be used in place of the mechanical type; and, (2) if the 155 kip tension could not be achieved, reduce the horizontal distance between bars and lower the tension requirement from 155 kips to 75 kips.

Preceeding under the aforementioned modified requirements, the rock stabilization program was completed on 20 December 1983 with a total of 8,459.5 feet of rock anchor bars having been installed. This rock stabilization program was successful in that no rock movement problems occurred during the Stage I excavation program.

Refer to Appendix; Section 10-1 for a complete synopsis concerning the rock reinforcement program.

SECTION V

EXCAVATION PROCEDURES

5-01 GENERAL - The contract specifications for construction of the Stonewall Jackson Dam required a specific sequence for excavation and construction. This sequence is fully described in Para. 4-02 of Section IV. Basically, the excavation procedures for this contract were typical for this type of structure. That is: (1) control the flow of the river; (2) remove overburden; (3) based on information obtained from exploratory borings, excavate rock to a foundation that is structurally acceptable; (4) construct dam; (5) place a grout curtain beneath the structure to restrict seepage flow through rock beneath dam.

5-02 OVERBURDEN EXCAVATION - After the clearing and grubbing operations had been completed, overburden removal began in August 1983. The overburden excavation of the left abutment was the first order of work for this contract because of the high priority given to the excavation for the Stage I diversion channel which was located on that side. After the overburden had been removed from the left abutment to the required slope and grade and diversion completed, the overburden excavation operation switched to the right abutment and proceeded down the abutment and across the valley floor. Essentially, the overburden excavation program was completed by January 1984 and, by the completion of the job, a total of 140,710 cubic yards of common material had been excavated.

The overburden excavation program was basically a standard operational procedure. That is; the overburden from the abutments was removed by dozers, loaded into 769 dump trucks by either a 988 endloader or a 235 backhoe, and hauled to specified spoil areas located upstream of the dam area. The material located at the toe of the abutments and across the valley floor was removed, when possible, by 631 scrapers and transported to the spoil areas. See Appendix; Section 10-1 for list of contractor's equipment.

5-03 ROCK EXCAVATION - Rock was defined in this contract as that material that would require removal by systematic drilling and blasting, loose boulders and rocks one cubic yard or more in volume, and earthlike materials of limited extent within excavation areas. The type of rock encountered in the dam excavation consisted of sandstones, shales, siltstones, claystones, indurated clays, and one major coal seam (Redstone). The contractor was required to so control his rock excavation operations so that materials suitable for use in the Stage I cofferdams construction would be stockpiled separate from his spoil material. However, becasue of poor physical qualities, most of the excavated rock was wasted except for a small portion which

was used as random fill material and some marginally acceptable sandstone excavation from the diversion channel and used for riprap. See Section 10-2 for location of spoil areas.

This contract also stipulated that if the contractor should market the coal (Redstone seam at approx. elev. 1000) encountered during his rock excavation program, the government would share in the amount received for its sale. However, the quantity and quality of the coal encountered during the excavation made it uneconomically feasible to sell. All coal, along with any other excavated material that was tested for acid drainage and found to be toxic, was disposed of in a left abutment spoil area located upstream of the dam. This special spoil area was located above elevation 1098 and sealed on all sides with impervious material.

The rock excavation program was basically divided into three distinct time periods: (1) September and October 1983 - Excavation for the Stage I diversion channel; (2) March 1984 to August 1984 - Excavation for the dam Monoliths 1-9 and the stilling basin with its appurtenant features; and (3) December 1984 to May 1985 - Excavation for dam Monoliths 10-16.

The procedure for removing the shot rock was the same as for the overburden excavation except for the very limited use of scrapers in the program. There was a total of 82,007 cubic yards of rock excavated during this contract.

5-04 LINE DRILLING, PRE-SPLITTING, AND PRODUCTION BLASTING

5-04.01 LINE DRILLING - Line drilling, described in the contract as drilling 2 to 3-inch diameter holes spaced not more than twice the hole diameter, center to center, along the excavation lines, was required at the downstream limits of the shear key in the stilling basin floor, at the vertical steps between monoliths, and the downstream excavation lines for Monolith 5, 6, 7, and 8. All of this vertical drilling using 3-inch diameter bits at 6-inch center to center spacing. To comply to the above requirements, 17,742 square feet of line drilling was performed under this contract.

5-04.02 PRE-SPLITTING - All rock faces against which concrete was to be placed required to be either line drilled or pre-split. All the holes that were drilled for pre-splitting were 3-inch diameter and were drilled with air track drills with a distance of either 18 inches or 24 inches from center to center. All the rock surfaces that required pre-splitting were cut on a 1 to 6 slope except for the sides of the Stage I diversion channel which was cut on a 1 to 4 slope. To produce the pre-split face, all holes that were drilled on 24-inch centers, and only alternating holes if drilled on 18-inch centers, were loaded with a combination of "Hercosplit WR" explosive and spacers. The top portion of the

hole was stemmed with limestone fragments and detonating cord was used to connect the holes. The shot was then initiated by a zero delay electric blasting cap taped to one end of the detonating cord.

The "Hercosplit WR" explosive that was used for pre-splitting is a water resistant, semigelatin, high explosive produced by Hercules Powder Company that is especially designed for pre-splitting. The type used on this job was packaged in 7/8-inch diameter by 24-inch long cartridges having paper sleeve connectors.

There was a total of 60,716 square feet of pre-splitting performed during this contract produced by an average powder factor of 0.018 lbs/s.f. Considering the variable types of rock involved, the results of the pre-splitting program were highly successful.

5-04.03 PRODUCTION BLASTING - Once the founding elevations had been established from the exploratory boring programs, and the rock excavation outline for the various structural features had been inscribed by either the line drill or pre-split method, the inner rock mass was removed to line and grade by systematic drilling, loading, and blasting.

In addition to the usual production blasting requirement that care must be taken so as not to damage any surrounding in-place rock outside the excavation limits or damage any pre-split or line drilled face, this contract required that balst hole drilling would stop three feet above final grade. This final three feet of rock was to be removed later by a separate operation of drilling full depth plus eight inches and then padding the bottom foot of the hole with sand prior to blasting. This method was used to reduce the possibility of blast damage to the final rock surface.

The production shot holes were 3 1/2-inch in diameter with spacing varying from 4-1/2 feet by 4-1/2 feet to 8 feet by 8 feet depending upon the hole depth. These production holes were loaded with Hercules Brand "Hercamix" blasting agent and "Unigel" explosive, stemmed, and shot through a variable delay, electric blasting cap system.

The production blasting program extended from September 1983 through April 1985 and produced a powder factor ratio that averaged 1-1/2 lbs/c.y. The contractor's cost in production blasting was incorporated into the price payed for rock excavation. See Appendix; Section 10-1 for additional information concerning the drilling and blasting programs.

5-04.04 BLAST VIRBRATION MONITORING - The contractor was required to furnish instrumentation and a seismograph operator to monitor and record all blasting vibrations with a restriction that the peak particle velocity at the nearest concrete structure would

not exceed 5 inches per second, except in Monolith 10 excavation where the peak particle velocity could not exceed 2 inches per second.

Instrumentation and consultation were provided by Vibra-Tech Engineers, Inc. of Rockville, Maryland. Thirteen blasts were monitored between 27 March 1985 at which time "flyrock" damaged the seismograph and before it could be replaced, the blasting program had been completed (02 April 1985).

All test results were within the specification limits.

5-05 EXCAVATION GRADES - Tentative founding elevations for the individual dam monoliths and the stilling basin had been established from information derived from pre-construction, exploratory boring programs. These elevations were provided to the contractor in the plans for construction of the dam. However, several of these founding elevations where changed after evaluation of the core that was obtained from the exploratory program that was required under this contract. These new excavation grades were judiciously provided to the contractor prior to the pertinent rock excavation program. See Appendix; Section 10-1 for information concerning establishment of founding elevations.

5-06 DEWATERING PROVISIONS - The contractor was required to provide sufficient dewatering equipment so that construction activities could be performed in the dry. This requirement was satisfactorily fulfilled by using various methods depending upon quantity of water encountered and existing physical conditions.

5-06.01 DEWATERING OVERBURDEN - Due to the nearly impervious nature of the overburden material, water seepage into the coffered areas during overburden removal was negligible. This small amount was controlled by the use of diversion ditches and strategically located sump pumps.

5-06.02 DEWATERING ROCK - Sandbags were placed, when needed, along the top of the excavated rock faces to control precipitation related surface water during concrete placement. Minor water inflow through the excavated rock faces associated with bedding planes and/or structural deficiencies in the rock were controlled by adjusting the concrete placement so as to force the inflow outside the limits of the placement or, if this was not practical, removed the water by sump pumps from an area intentionally left slightly low during concrete placement. If the quantity of inflow was extensive and/or considered detrimental to concrete curing, PVC standpipes, singular or interconnected, were extended through concrete from the source to an elevation above the water's static

head and then the pipe(s) were grouted by the tremie method.

The above described dewatering techniques were used during all foundation concrete placements except for dam Monolith 12. Due to the fault zone related water inflow encountered in the Monolith 12 excavation, two additional dewatering methods were incorporated. First, a verticle, 24-inch diameter CMP pipe was centered and sealed around an open, 6-inch diameter core boring hole (#231) located in the upstream half of the foundation floor. By continual pumping from the core hole, the water table in the immediate area was lowered below the founding rock surface. Pumping was continued until height of concrete placement exceeded the static water level and at that time, this casing was gravity grouted. Second, at the major water inflow (est. 75-100 g.p.m.) point located at the extreme downstream left corner of the excavation, a vertical, 24-inch diameter CMP pipe was installed to encase the inflow. A submersible pump was used to control this water during concrete placement. Because of the quantity and quality of the water in this sump, it was not grouted. Instead, the CMP casing was extended to top of ground and capped with the expectation that this water source can be incorporated into the dam's water supply system. See Section 10-2 for individual monolith dewatering information.

5-07 FOUNDATION PREPARATION - Since all structures that pertained to the dam construction required founding on competent bedrock, the protection of the founding rock surface during the period of time from excavation to concrete placement was almost as important as the final cleanup and rock treatment operations conducted just prior to concrete placement.

5-07.01 DETERIORATION PROTECTION - As stated in Section IV, fibercrete was used as a protective treatment for the exposed rock surface along the sides of Stage I diversion channel and the Redstone coal seam exposed on the left side of the Stage I cofferdam excavation. Also, the floor of the diversion channel was covered with concrete for protection. The fibercrete treatment requirement was limited to the construction of the Stage I cofferdam program only and during this period, 2,611 square yards of rock surface was protected by fibercrete.

Other vertical or sloping argillaceous rock surfaces of the foundation, or any rock deemed necessary, which were exposed, was protected from deterioration during the interim between exposure of the rock and placement of concrete by a sprayed on protective film. The material used in spraying was Celtite 42-51 Hi-Seal epoxy resin emulsion, a water based material with 30% solids. A total of 2,782 square yards of rock surface was protected by this epoxy during the excavation program.

Finally, for the protection of the shale or shaly portions of the

horizontal surfaces of the rock foundations against deterioration from work activity as well as exposure, the contract specified that, during the rock excavation program, a three foot layer of rock was to be left in the bottom of each foundation. This rock layer was to be shot and removed just prior to placing concrete. Since the removal of this rock from the deep pits, which some of the monolith foundation excavation required, would be a considerable problem to the contractor, they requested and received permission to eliminate this requirement. The contractor's proposed method of protecting the foundation rock surface was: shoot and remove rock to final grade during his rock excavation program; perform intermediate cleanup for inspection and acceptance of founding grade; if approved, the foundation floor was then covered by a polyvinyl membrane, which in turn was covered with 6-10 inches of sand. This covering was removed for final foundation cleanup and treatment just prior to concrete placement. This method was used and was very successful in the required protection of the rock surface.

5.07.02 FINAL CLEANUP AND TREATMENT - Immediately prior to the initial concrete placement for a dam monolith, a final foundation cleanup operation was performed. This operation began after the protective cover had been removed and all rock surfaces that would be in direct contact with concrete received the treatment. This hand cleaning operation consisted of barring, picking, wedging, and jackhammering to produce a sound and unshattered rock surface. After the unsound rock had been removed, the rock surface received an air/water jetted washing. Next, the foundation rock was mapped and, during mapping, checked for structural defect such as fractures, joints, faults, and weathered bedding planes. If any of these defects were encountered, they were treated with dental concrete or by brush grouting. A final cleaning by broom and air/water was performed just prior to concrete placement.

The above procedure applied to the rock foundation for all concrete structures. A total of 8,148.4 square feet of rock surface received this treatment and during this operation, 210 cubic yards of dental concrete was placed.

5.08 SAFETY - Safety precautions required during the construction program included: (1) installing rock bolts in unstable rock above an open excavation and the vertical line drilled rock face between monoliths; (2) rock anchors installed to reinforce the rock between Stage I diversion channel and the monolith excavation; (3) installation of No. 9 gage, 2-inch diamond mesh chain link fabric on all excavated rock surfaces that exceeded 20 feet in height. A total of 21,150 square feet of this fabric was used on the rock surface during the Stage I construction program. During Stage II construction, 11,771 square feet of rock face was covered with the fabric that had been removed after Stage I construction was completed.

Other than the above special requirements, the applicable safety regulations as described in Safety Manula EM 385-1 were followed during the construction program.

SECTION VI

FOUNDATION ANCHORS AND ROCK BOLTS

6-01 GENERAL - The only structure in this contract that required foundation anchors was the stilling basin concrete slab. Tensioned rock bolts were used to reinforce the rock between the Stage I diversion channel and the monolith excavation and, they were also installed in certain areas of the monolith excavation as a secondary support of the rock.

6-01.1 FOUNDATION ANCHORS (Between October and December 1984) - A total of 24,280 pounds of No. 14 bar was installed during the rock anchor program for the stilling basin. These bars, ranging from 24 to 26.5 feet in length and having a standard 90 degree hook were installed and grouted in 3.5-inch diameter vertical holes that had been drilled approximately 18-feet into rock. Two air track drills performed a combined total of 1,670 lineal feet of hole drilling into rock for this program. See Section 10-1 for installation details.

6-01.2 ROCK BOLTS - Rock reinforcement near the Stage I diversion channel and for the protection of the rock surface of the dam related structures was specified to be accomplished by installing tensioned mechanically anchored rock bolts. When the contractor had problems during the test program of achieving required tension of the anchors, they requested and received permission to use the dywidag threadbar bolt system with celtite resin cartridge bonding in lieu of the mechanical anchored type of bars. The rock reinforcement program for the Stage I diversion channel area is discussed in paragraph 4-03 of Section IV "Special Design Considerations" in this report. The total footage of anchor bolts installed during this program was 8,459.5 lineal feet.

When the rock cut faces were covered with chain link fabric, 1 3/8-inch diameter threadbar rock bolts were used to support the fabric. These anchors were installed three feet into rock on two foot centers so arranged that the mesh protection could be rolled up as concrete placement progressed upward. The mesh was attached to the anchors by a nut secure 6-inch by 6-inch plate. During this contract, a total of 231 anchor bolts were installed for this particular program.

The third program in this contract that specified using rock bolts was for the secondary support of the rock in the monolith excavation faces. Again, in lieu of the mechanical anchor type bolt, the celtite resin secured type was used and these 1 3/8-inch diameter threadbar bolts were installed 15 feet horizontally into the rock face on rows at a 5-foot spacing beginning 5 feet from the top of the cut. After installing the 5-inch by 7-inch bearing

plates, these bolts were tensioned to 50,000 pounds. Additional rock bolts were similarly installed, lengths and inclination adjusted to conditions, in areas where separation of the rock face along vertical joints had occurred or was likely to occur. Overall, 3,150 lineal feet of this type of rock bolts were installed under this contract.

SECTION VII

FOUNDATION TREATMENT

7-01 GENERAL - The foundation treatment for the Stonewall Jackson Dam structures consisted of: (1) dental treating or "broom" grouting the final foundation rock surface to correct structural deficiencies in the rock surface, such as open joints and faults, in order to eliminate seepage paths; (2) making "plug" concrete placements to restructure irregularities of the rock surface to obtain an acceptable even surface for mass concrete placement; (3) drilling 3-inch diameter pressure relief holes in the stilling basin floor, (4) installing a grout curtain beneath the dam structure; and (5) drilling 2 7/8-inch diameter pressure relief holes into the dam's foundation.

7-02 DENTAL TREATMENT - Dental treatment of all open joints, cracks, faults, shear zones or similar features in the rock surface, including open, previously drilled holes, was required. These man-made or structural defects in the rock surface were hand cleaned, removing all soft, brecciated or decomposed material to a depth of at least three times the width of the opening and backfilled with either neat grout or concrete depending upon the size of the opening. Payment for this operation was made by the volume of concrete or neat cement required to backfill the rock surface defect. Of the 188 cubic yards of dental treatment performed during this contract, 74% (140 cubic yards) were done in the Monolith 11/12 fault zone. See Appendix 10-1 for dental concrete data.

7-03 PLUG CONCRETE - When an irregularity in the excavated rock surface occurred, such as excavation for a sump or over excavating, that area was treated with "plug" concrete. If the irregularity was considered contractor's negligence, the treatment was at contractor's expense. However, if rock structure caused the irregularity, payment was made for the concrete.

7-04 DRAIN HOLES - Pressure relief drain holes were drilled in the stilling basin and beneath the dam structure. Since the drilling of these holes occurred during separate time periods and had different requirements, the two operations will be discussed individually.

7-04.1 STILLING BASINS - The contract specified that 2 7/8 inch diameter holes, sloped 1 on 4 were to be drilled into the stilling basin foundation through 4 inch diameter PVC pipe set 1 foot in to the top concrete slab. These holes were to be drilled in specific locations, using rotary drills with diamond bits and circulation

clean water. The contractor requested and received permission to alter this specification so that: (1) the 4-inch diametered PVC pipe would extend from top of rock to top of concrete thus eliminating drilling through concrete; and (2) using an air track drill with circulating water in lieu of a rotary drill. This change was purposed at no additional cost to the government and approved pending satisfactory results. The results from the modified program was acceptable with the only problem being the time involved with drilling through wooden plugs that the contractor had installed in the bottom of the PVC pipe to protect the inside of the pipe during concrete placement. After the drain holes were drilled, they were washed and backfilled with pea gravel to within one foot of the top of concrete. This top foot was sealed with rags until time for diversion of the river through the dam's sluices at which time, the rags were removed and the holes completely backfilled wiht pea gravel.

The stilling basin drain hole drilling program was conducted during the period between 05 April 1985 and 15 April 1985 and consisted of 23 drain holes having a combined total drilling footage of 1,532.5 lineal feet. See Appendix 10-1 for additional details concerning this program.

7.04.02 DAM FOUNDATION - After completion of the dam's foundation curtain grouting program, drain holes were drilled on 10 foot spacing, 40 feet vertically into the foundation beneath the dam structure. This program consisted of drilling 62, 2 7/8-inch diameter holes through 4-inch diameter steel pipes inclined 10 degrees downstream and embedded 1 3/4-feet into the concrete floor of the drainage gallery. "Gearmac" electric drilled were used in this program with a general procedure of coring through the concrete using a "NX" size diamond bit and then switching to either a 2 7/8 inch diameter tricone or plug bit to drill in rock. Due to a better production rate, the diamond impregnated plug bit was used in rock during most of the drilling program. After the holes had been drilled, they were washed, measured for correct depth, and capped at floor level leaving the side pipe to the gutter open for drainage.

This drilling program was performed between 05 May 1986 and 03 June 1986 and consisted of 3,463.5 lineal feet of drilling. See Index for individual drain hole data and sketch of drilling details.

7.05 CURTAIN GROUTING (Between 02 January 1986 and 03 June 1986)
A grout curtain was installed beneath the concrete dam structure to restrict the leakage through rock under the dam. This curtain, constructed in two zones, extended from founding elevation 50 feet vertically into the foundation and spanned the full length of the dam with fanning in the abutments to assure full coverage of the rock below the spillway elevation of 1082. See Section 10.2 for

location and details.

The grout curtain was developed by drilling and grouting a single line of 1 1/2-inch diameter holes angled 20 degrees both upstream and towards the appropriate abutment with directional overlap in the middle of the curtain to obtain full coverage. Per contract requirements, this drilling and grouting program was not initiated until the dam structure was essentially completed and the program was performed from the drainage gallery with interlocking of the abutment fan holes being achieved by supplemental grout holes drilled from the surface of each abutment.

The drilling and grouting for the grout curtain was done by zones using the split spacing, stage grouting method. The first zone extended 30 feet vertically from founding elevation and the second zone extended 20 feet downward from the bottom of the first zone. The specified minimum distance between grout holes in the curtain was 5 feet which was achieved by a required procedure of drilling and grouting primary holes, spaced 10 feet apart, first and then splitting the distance between the primary holes with secondary holes. Consequently, both the primary and the secondary series of holes were required for the entire depth of the curtain. The split spacing of holes in either of the two zones beyond the secondary level depended upon two factors. The first factor being that tertiary holes, which would result in a minimum spacing between holes of 2 1/2 feet, were mandatory if these holes would penetrate into the vertical rock faces that resulted from differential founding elevations of adjacent dam monolith, and if these rock faces exceeded 5 feet in height. This was done to ensure protection against leakage along these critical areas. It should be noted here that such emphasis was given to these vertical rock faces that additional grouting was performed in these areas. This additional grouting was performed in these areas. This additional grouting consisted of drilling and grouting a vertical hole located 1 foot behind each monolith joint rock face to at least a depth equal to the height of the face, and also, in two instances, monolith joint face of 12/13 and 13/14, additional holes were drilled and grouted from the floor of the drainage gallery. These holes were located just inside each rock cut face and the angles of the holes varied so as to provide treatment along the length of the rock face.

Other criteria used for the groutng operations were: (1) pressure testing and grouting pressures were regulated so that the minimum true applied pressure would be eual to the head pressure of the future pool should it reach spillway elevation (1082). Maximum pressure applied never exceeded the burden pressure of the dam structure. (2) Pressure grouting of a hole stage was required when, during a five minute pressure test with water, water injected into a hole exceeded the average of 0.2 cubic feet per minute; (3) the grouting header would be located near or above the elevation of the grout pump; (4) pressure grouting for a particular stage was considered sufficient when the hole held it

least three-fourths of the maximum pressure required for that stage; and (5) during grouting, discontinue and wash hole if desired results had not been achieved after approximatley 150 bags of cement had been injected. Grouting was continued in that hole after a period of time delay for grout in that hole to stiffen.

The grout curtain was subdivided into sections of approximately 100 feet in length to facilitate the contractor's operations and to comply with the contract restrictions that: (1) no drilling operations could be performed within approximately 100 feet of a grouting operation until the grout had set for a period of 24 hours; and (2) primary holes within a section would be completed by stage development to the bottom of the first zone before the second and succeeding series of holes are started. Before drilling and grouting operations began, the pipes that had been embedded during concrete placement were divided into designated sections and each pipe in a section was numbered and, based on distance apart, assigned a drilling and grouting priority (primary, secondary, and tertiary). Those holes angled towards the left abutment were divided into three sections and those angled towards the right abutment divided into four sections. The surface drilling and grouting operations that were performed at the abutments were conducted after the drainage gallery program had been completed.

4-05.01 DRILLING AND GROUTING PROCEDURES - The procedure for constructing the dam's grout curtain was as follows: (1) locate and install nipples into those embedded pipes within a section that had been designated as primary holes; (2) set up electric drills at the correct drilling angle over the nipples and drill, using the concave, plug-type bortz bits of EX-size (1-1/2 inch o.d.), the primary holes to the first stage in zone one. The depth of a stage in a hole could be: (a) the entire depth of the zone; (b) a partial depth at which an appreciable amount of drill water had been gained or lost during drilling; or (c) a predetermined shallow depth within the first zone used to assure pressure treatment at the rock/concrete contact. This shallow depth grouting was performed only on: the primary holes in the first two sections worked (1 and 3); primary holes at the abutment fans; and tertiary holes in the foundation faulted area of Monoliths 10,11, and 12. After primary holes within a section had been drilled to Stage I, the drills were moved to work in another section which was located at least 100 feet away from the grouting operation. This method of drilling in one section while grouting in another section and leaving an open section between the operations was a standard procedure during the curtain grouting program.

First stage holes in the drilled section were washed, pressure tested and, if required, pressure grouted. The contractor first tried to use shut off valves attached to the hole nipple for his pressure testing and grouting operations. However, this was

unsatisfactory because the nipples had become loose or the threads stripped during the drilling operations. Switching to a short mechanical packer and seating it in the pipe embedded in concrete proved to be the most efficient method for pressure retention.

After primary holes within a section were stage grouted to the bottom of zone one, the secondary holes in that section were similarly drilled, tested, and grouted. If required, succeeding series of holes, as determined by the "split spacing method, were drilled and grouted to the depth of the first zone in a like manner until the first zone of that section was completely grouted. The process of successively drilling and grouting to additional depths in stages for the first and second series of holes and then, if necessary, for succeeding series of holes were repeated for the second zone of the sections until all sections along the grout curtain had been grouted.

After the drilling and grouting operations inside the drainage gallery had been completed, the surface grout holes, located at each abutment, were drilled and grouted. It was specified in the contract that the extension of the grout curtain landward from the ends of Monoliths 1 and 16 would be accomplished by drilling and grouting holes from the top of rock surface. However, because of construction priority, the contractor requested and received permission to perform this work after construction in these areas had reached final grade. This modification as to number of holes, location, drilling angles and additional depths was to be done at no additional cost to the goverment.

During the curtain grouting program, grout mixes were based on the preceeding water test data. Generally, if the water injection rate averaged less than 1 c.f.m. during the test, grouting would begin with a water-cement ratio fo 2.65 by weight. If the water injection rate exceeded 1 c.f.m., a 1.98 water-cement ratio was used initially. During the grouting program, the rate of grout injection was continuously monitored and the water-cement ratio adjusted correspondingly.

7-05.02 MIXES - The grout mixes that were used consisted of: (1) Water - obtained from the West Fork River and metered at either the 72 cubic foot capacity, double-tub mixer initially located beside the right training wall and later moved to the left side; or, the smaller mobile, 5 cubic foot mixer located inside the drainage gallery. Which mixer to be used depended upon anticipated quantities of grout needed; and (2) Cement Type I, furnished in 94 lbs. bags. The cement was shipped to the project in lots of 550 bags and stored in a 40 foot trailer located beside the grout mixing plant. If the grout was to be mixed in the smaller mixer located inside the drainage gallery, cement was hand carried to that mixer.

Statistically, a total of 100.15 hours was spent pressure testing

grout holes and 2,130 cubic feet of solids (cement) were placed in the 15,558.2 lineal feet of holes drilled for the grout curtain program for an average of approximately 0.14 cubic feet per lineal foot drilled. This average was considerably less that the average (0.91 cf/ft) estimated for this contract.

7-05.03 EXPLORATORY BORINGS - When an area of the grout curtain had been completed, the effectiveness of the grouting operation was checked by drilling and pressure testing an "NX" size exploratory core boring located within the grout curtain. Eight such borings, with a combined total of 530.4 lineal feet, were drilled and tested during the grout curtain program resulting in no supplemental grouting required. See Appendix 10-I for additional details concerning the curtain grout program.

7-06 IMPERVIOUS FILL - Compacted impervious fill was used in the temporary Stage 1 cofferdam construction. This fill material was placed in the dry on prepared, clean rock surface and payment for material and placement was included in the unit price for cofferdam construction.

As a permanent feature, impervious material consisting of sandy clay or clayey sand was used for the fill tie-in on the left bank between Monolith 16 and the rock surface. The material for this impervious plug was placed in compacted, thin layers from approximate elevation 1082 to 1100. After compaction, moisture content was checked for the required plus or minus 2 percent of optimum. 1,744 cubic yards of impervious fill was placed during this program.

7-07 RANDOM BACKFILL - Random backfill which was placed in the area between permanent construction and the excavated rock slopes consisted of excavated rock spalls and fines of sandy gravel size and was placed in maximum 18-inch horizontal layers. No compaction was required in areas between the upstream face of the dam monoliths and the excavated rock slopes.

Other random backfill used in the permanent features grading consisted of any and all types of excavated pervious material that was suitable for compacted stability. 66,872 cubic yards of random backfill was placed during the dam construction.

SECTION VIII

INSTRUMENTATION

8-01 GENERAL - Instrumentation installed during dam construction to monitor the stability of the structure consisted of uplift pressure cells and horizontal and vertical controls.

8-01.01 UPLIFT PRESSURE CELLS - A total of eighteen (18) uplift pressure cells were installed, six (6) each in Monoliths 5, 8, and 12, after final foundation preparation was completed. Except for Monolith 12 in which location and hole depth for some cells were modified because of the fault that transversed the foundation, the standard cell installation procedure was as follows: (1) after the cell locations were marked and approved, an air-track drill using a plug bit drilled a 4-inch diameter hole 4 feet into the foundation; (2) a slotted tee pipe was centered at the hole and the hole filled with No. 8 gravel; (3) a wooden box was set on the foundation surface around the hole, filled with gravel and enclosed with a top; (4) the box was covered with at least 6 inches of lean concrete; (5) lengths of Schedule 120 PVC pipe were ran from that section protruding from the cell box to a point directly beneath the reading station and extended vertically upward during concrete lift placements to a recess located in the drainage gallery; and (6) protected at the read out station by steel pipe, the existing ends of the PVC pipe were capped with a shutoff cock and snap lock connector.

During the curtain grouting operation, an attempt was made to protect the integrity of these cells by: checking for cell gage fluctuation when water pressure testing grout holes in the vicinity; and (2) applying a steady air pressure, equal to grouting pressure, to applicable cells when grouting was being performed in the immediate vicinity.

8-01.02 HORIZONTAL AND VERTICAL CONTROL - After completion of the dam construction, the contractor installed 16 alignment plugs, one in the approximate center of each monolith, and 4 reference monuments, two on each abutment.

Punching and initial readings for these alignment plugs were performed by the government.

SECTION IX

POSSIBLE FUTURE PROBLEMS

9.01 FAULT ZONE - When the grout curtain was constructed in the Monolith 11, 12, and 13 area, grout takes were less than expected. This was probably due to the impervious matrix of the gouge filled fault and related fractured zones. Although sliding and settlement of the structure is not anticipated as a problem in this area, underseepage through the fractured zones into the foundation drains may cause a potential pumping problem inside the drainage gallery.

9.01.01 RECOMMENDED OBSERVATIONS - Close monitoring of foundation drain hole flows during initial filling of dam and during periods of high pool.

9.02 LEFT ABUTMENT OVERBURDEN - The stability of the overburden on the left abutment, causing continual failures in the cut slopes, was evident during dam construction. If this overburden movement continues, the resultant slope failure will present problems with clean-out of concrete gutters along the dam access road and, in the case of a major failure, blockage of access road and/or parking lot.

9.02.01 RECOMMENDED OBSERVATIONS - Install and monitor additional horizontal controls to determine the magnitude of the potential problem.

SECTION X

APPENDIX

10-01 FOUNDATION RELATED STATISTICAL DATA PAGE

A. Chronological Sequence of Design Memoranda... A-1

B. Stonewall Jackson Dam Data.................... B-1 - B-2

C. Project Major Construction Contracts......... C-1

D. Government Personnel.......................... D-1

E. Contractor's Personnel - Subcontractors...... E-1

F. Contractor's Equipment........................ F-1

G. Contract Quantities (partial)................ G-1 - G-4

H. Founding Elevations........................... H-1 - H-2

I. Chronological Sequence of Construction....... I-1 - I-2

J. Curtain Grouting.............................. J-1 - J-95

K. Dental Concrete............................... K-1

L. Explosive Data................................ L-1 - L-24

M. Line Drilling.................................. M-1 - M-[illegible]

N. Drainage Gallery Drains........................ N-1 - N-4

O. Instrumentation............................... O-1 - O-15

P. Rock Anchor Bolts.............................. P-1 - P-[illegible]

Q. Modifications.................................. Q-1 - Q-15

R. Correspondence................................ R-1 - R-[illegible]

"A"

CHRONOLOGICAL SEQUENCE OF DESIGN MEMORANDA

DESIGN MEMORANDA	SUBMITTED	APPROVED
General Design	20 Jan 71	23 May 72
Real Estate - Dam Site, Reservoir and Public Access and Use Areas	15 May 70	2 Aug 71
Supplement No. 1 - Land Needed for Relocation of Equitable Gas Company's Compressor Station	7 May 71	17 Aug 71
Supplement No. 2 - Section of State of West Virginia Route 30	29 Oct 71	13 Jan 72
Supplement No. 3 - Real Estate Isolated Land	24 Jan 79	21 Feb 79
Supplement No. 4 - Real Estate Isolated Land	4 Dec 78	21 Dec 78
Relocation of Equitable Gas Company-Owned Skin Creek Compressor Station and Connecting Pipelines	9 Jul 70	24 Aug 70
Relocation of U.S. Route 19	31 Oct 73	18 Dec 73
Utilities Relocations - Part I - Gas Wells, Lines & Appurtenant Facilities	15 Feb 74	19 Jun 74
Utilities Relocations - Part II - Power and Telephone Lines	19 Oct 78	9 Nov 78
Feature Design Memorandum - Relocation of Baltimore and Ohio Railroad	17 May 74	3 Jul 74
Feature Design Memorandum - Relocation of Route 30 Section 2 & Remaining Highways	23 Mar 79	4 Jun 79
Dam and Appurtenances	1 Feb 80	27 Mar 80
Design Memorandum No. 7 (Master Plan)	3 Sep 82	29 Nov 82

"B"

STONEWALL JACKSON LAKE
WEST FORK RIVER
WEST VIRGINIA

DAM AND APPURTENANCES

PERTINENT DATE

General

Authorization................Flood Control Act of 7 November 1977
(PL 89-789, 89th Congress)
Purpose...........Flood Control, Water Supply, Water Quality and Recreation
Location of Dam on West Fork River, miles upstream of Fairmont, West Virginia... 73
Drainage Area.. 102
Type of Dam..........Concrete gravity with uncontrolled spillway
Length of Dam, feet.................................... 620
Height of Dam (above streambed), feet...................... 95
Spillway Length (uncontrolled concrete ogee), feet.......... 117

Elevations, feet, msl

Top of Dam	1102.0
Flood Control Pool (Spillway Crest)	1082.0
Summer Pool	1073.2
Winter Pool	1068.2
Minimum Pool	1038.5
Streambed	1007.0
Flood of Record (June 1950)	1027.0
Standard Project Flood	1086.48
Spillway Design Flood	1098.20

Reservoir Area, acres

Full Flood Control Pool	3,470
Summer Pool	2,650
Winter Pool	2,150

Reservoir, Storage, acre-feet

Summer Flood Control	26,480
Winter Flood Control	38,550
Low Flow Augmentation (maximum available)	45,050
Minimum Pool	3,120
Total Volume	74,650

Maximum Outflow, cfs*

Flood of Record (June 1950)	2,300
Standard Project Flood	7,025
Spillway Design Flood	27,800

*Low Flow Augmentation Outlets Closed

Spillway

Type	Uncontrolled
Crest elevation, msl	1082.0
Length, feet	117
Width of Piers, feet	4
Effective Length, feet	105
Design Flood Discharge Capacity, cfs	27,800

Outlet Works

Number of Flood Control Sluices	3
Number of Water Quality Control Sluices	2
Size of Flood Control Sluices, feet	3.5 x 7.0
Invert of Flood Control Sluices, msl	1014.0
Size of WQC Sluice, feet	2.5 x 4.0
Invert of WQC Sluice, msl	1018.0

Stilling Basin

Length, feet	71
Width, feet	117
Elevation of Floor, msl	1008.0
Elevation of Top of End Sill, msl	1010.0
Elevation of Top of Training Wall, msl	1030.0

"C"

STONEWALL JACKSON LAKE PROJECT
MAJOR CONSTRUCTION CONTRACTS

Contract No. DACW59-	Description	Contractor	Completed
78-C-0065	Relocate Rt. 30-1	J.F. Allen	June 80
82-C-0015	Relocate Rt. 19-1	Weiss Bro.	Aug. 84
82-C-0021	Relocate Rt. 19-2	J.F. Allen	June 84
82-C-0024	Drill New Storage Wells	Alan Stone	Nov. 82
82-C-0095	Dam Access Road	Alan Stone	Dec. 83
83-C-0003	Relocate Rt. 19-3	Weiss Bro.	Oct. 84
83-C-0046	Equitable Gas Access Roads I	J.F. Allen	Jan. 84
83-C-0053	Dam	J.F. Allen & Wiley N. Jackson	Incomp.
84-C-0075	Roanoke School	P. Diniaco & Sons	Jul. 86
84-C-0078	Plug Old Storage Wells	N.R.M.	Nov. 84
84-C-0088	Relocate Rt. 30-2	J.F. Allen	Dec. 86
85-C-0024	Relocate Rt. 30-3	J.F. Allen	Nov. 86
85-C-0054	Equitable Gas Access Roads II	Viking Coal	Oct. 86
85-C-0058	B & O Railroad	J.F. Allen	Oct. 86
86-C-0037	Relocate Rt. 44	J.F. Allen	Incomp.
86-C-0049	Equitable Gas Access Roads III	J.F. Allen	Incomp.
86-C-0088	Maint. Complex	Guy Johnson Const.	Incomp.
86-C-0132	Reservoir Clearing	Robbinsville Const.	Incomp.

10-01

"D"

GOVERNMENT PERSONNEL

PITTSBURGH DISTRICT OFFICE

Design.................................. Joe Coletti (Branch Chief)
Project Manager......................... John Gribar
Architect............................... Bernie Weiner
Structural Engineer..................... Gus Rambo
Mechanical Engineer..................... Dave Fitzgerald
Electrical Engineer..................... Mark Zelkovic
Geology......................... Marshall Fausold (Branch Chief)
Stuart Long, Robert John
Instrumentation......................... Tom Churilla

CONSTRUCTION - HUNTINGTON DISTRICT OFFICE RESIDENT ENGINEER OFFICE

Resident Engineer............................... William F. Woodburn
Ronald C. Harris
Asst. Resident Engineer......................... Gordon Loudin
Office Engineer................................. C. E. Dailey
Material Engineering Technician................. R. C. Young
Civil Engineer Technician....................... J. C. Lowther
Geologist....................................... David Nugen
Supervisory Construction Representative..... William "Red" Hamric
Construction Representative..................... Dale Smith
Construction Inspectors......................... Wayne Smith
C. F. Parrotte
G. L. Warner
H. W. Harris
W. G. Kisner
Construction Secretary.......................... Marsha Lloyd

"E"

CONTRACTOR'S PERSONNEL

J.F. ALLEN COMPANY & WILEY N. JACKSON COMPANY

Project Manager	Lou Hutcherson
Project Manager	John Kibler
Project Engineer	Emilio Mendenilla
Party Chief	Dewey Moore
Master Mechanic	Addie Hicks
	Gary Bosely
Quality Control	Edward Paugh
	Gerald Carter
	Walter Gordon
	Randy Bohan

SUBCONTRACTOR	BASIC AREA OF WORK
Belot-Hoy	Batch Plant/Concrete
Barnes and Brass Electricians	Electrical
Viking Fabricators, Inc.	Metal Work
Industrial Heating & Plumbing Co.	Hydraulics/Plumbing
Air Placement Cement Co.	Protection of Rock Surface
Crown Pressure Grouting Co.	4" Dia. Exploratory Core
B. H. Mott & Sons, Inc.	6" Dia. Exploratory Core
Pennsylvania Drilling Co.	Foundation Grouting
Centurial Products Corp.	Prestressed Concrete Beams

10-01

"F"

CONTRACTOR'S EQUIPMENT

CRANES

1 - 42 American
1 - 2250 American
2 - 3900 Manitowac
1 - 312 Grove
1 60 Grove

TRUCKS

4 - Concrete trucks
3 - 769 Cat (back dump)
1 - Flat bed
1 - F-700 Ford
1 - Fuel truck
1 - Grease truck
1 - Mack dump truck
1 - Mechanic's truck
1 - Water truck

DOZERS

1 - D-6 Cat
1 - D-7 Cat
1 - D-8L Cat
1 - D-8K Cat
1 - D-9 Cat
1 - D-9L Cat

SCRAPERS

4 - 631 Cat

DRILLS

1 - Davey
3 - Joy Air Tracks

ENDLOADERS

1 - 920 Cat
1 - 977 Cat
1 - 988D Cat

BACKHOE

1 - 235 Cat

MISC.

1 - Vibratory roller
1 - Sheep-foot roller
1 - 570 Grader
1 - Water blaster
Light plants
Hand tools

10-01

"G"

COMPARISON OF ACTUAL VS. ESTIMATED BID QUANTITIES

BID ITEM	DESCRIPTION	ESTIMATED QUANTITY	ACTUAL QUANTITY	UNIT	UNIT PRICE
4	Cofferdam-Diversion Care of water	1	1	Job	650,000.00
5	Excavation, Common	129,290	140,710	CY	3.75
6	Excavation, Rock	79,980	82,007	CY	7.50
7	Line Drilling	10,860	17,742	SF	2.00
8	Presplitting	56,870	60,716	SF	1.10
9	Random Backfill	32,200	66,872	CY	5.00
10	Rock Fill	4,290	6,915	CY	5.00
11A	Final Foundation Cleanup	6,500	8,148.4	SY	25.00
11B1	Dental Treatment (First 50 CY)	50	50	CY	500.00
11B2	Dental Treatment (Over 50 CY)	100	160	CY	500.00
12A	Rock Bolts (Diversion Channel)	6,300	8,459.5	LF	13.30
12B1	Rock Bolts (Monolith Faces First 2025 LF)	2,025	2,025	LF	7.00

BID ITEM	DESCRIPTION	ESTIMATED QUANTITY	ACTUAL QUANTITY	UNIT	UNIT PRICE
12B2	Rock Bolts (Monolith Faces Over 2025 LF)	1,050	1,125	LF	7.00
13A	Chain Link Fabric Furnish & install	20,700	21,150	SF	1.00
13B	Chain Link Fabric (Reinstall)	18,400	11,771	SF	0.65
14	Rock Bolt Supporting Chain Link Fabric	1,300	231	EA	25.00
15A	Protection of Rock Surfaces (Epoxy Coating)	1,085	2,782	SY	6.50
15B	Protection of Rock Surfaces (Shotcrete)	1,300	2,611	SY	35.00
19	Impervious Fill	830	1,744	CY	10.00
32	Instrumentation	1	1	Job	26,000.00
34	Drill and Install Anchor Bars for Stilling Basin	1,670	1,670	LF	5.00
35	Drill Drain Holes for Stilling Basin	1,810	1,532.5	LF	20.00
67A	Exploratory Drilling Mobilization & Demobilization	1	1	Job	3,500.00

BID ITEM	DESCRIPTION	ESTIMATED QUANTITY	ACTUAL QUANTITY	UNIT	UNIT PRICE
67B1A	Exploratory Drilling Rock W/O Core (First 350 LF)	350	350	LF	8.05
67B1B	Rock W/O Core (Over 350 LF)	80	43.5	LF	8.05
67B2A	Exploratory Drill 4" Dia. Core (First 510 LF)	510	510	LF	16.10
67B2B	Exploratory Drill 4" Dia. Core (Over 510 LF)	100	363.2	LF	16.10
67C	Exploratory Drilling Seal Holes W/Cement	175	160	CF	10.35
68A	Foundation Drilling & Grouting (Mob. & Demob.)	1	1	Job	40,000.00
68B	Foundation Drilling & Grouting (Care of Water/Drill Cuttings)	1	1	Job	3,500.00
68C1A	Drill 1-3/8" Grout Holes in Gallery (First 12,000 LF)	12,000	12,000	LF	8.05
68C1B	In Gallery (Over 12,000 LF)	2,700	2,513.2	LF	8.05
68C2A	Drill 1-3/8" Grout Holes in Surface (First 1,000 LF)	1,000	1,000	LF	8.05
68C2B	Surface (Over 1,000 LF)	200	45	LF	8.05
68D	Drill 2-7/8" Drain Holes	3,800	3,463.5	LF	8.05

BID ITEM	DESCRIPTION	ESTIMATED QUANTITY	ACTUAL QUANTITY	UNIT	UNIT PRICE
68E	Drill Exploratory Holes (NX Size)	710	530.4	LF	8.05
68F	Pressure Test Exploratory Holes	10	8	EA	575.00
68G	Pressure Test Grout Holes	130	100.15	HR	52.00
68H1A	Placing Cement in Gallery (First 300 Hr)	300	300	HR	145.00
68H1B	Gallery (Over 300 Hr)	50	17.02	HR	145.00
68H2A	On Surface (First 50 Hr)	50	13.82	HR	145.00
68H2B	On Surface (Over 50 Hr)	15	0	HR	145.00
68I1	Portland Cement in Grout (First 12,000 CF)	12,000	2,130	CF	8.05
68I2	Grout (Over 12,000 CF)	2,500	0	CF	8.05
68J1	Pipe & Fittings (Grout Holes)	300	300	EA	30.00
68J2	Pipe & Fittings (Gallery Drains)	62	62	EA	250.00
68J3	Pipe & Fittings (Additional Grout Pipes)	20	16	EA	30.00
68J4	Pipe & Fittings 2" Csg. for Surface Grouting	490	490	LF	7.00

NOTE: Actual quantity totals may change due to pending modifications/claims.

COMPUTATION SHEET

DATE

PAGE 1 OF 2 PAGES

SUBJECT

FOUNDING ELEVATIONS - STONEWALL JACKSON DAM

COMPUTATION

STAGE I CONSTRUCTION

NO.

COMPUTED BY

CHECKED BY

Mono. No.	Description	Width Feet	Length Feet	Tentative Found. Elev.	Exploration Boring No.	Revised Found. Elev.	Ref. Memo Date	Ave. Found. Elev.
1	Dam Monolith	25'	41.14	1046	217	1045	3-5-84	1045
2	Dam Monolith	40'	59.30	1025	216	1022	3-5-84	1022
3	Dam Monolith	40'	80.16	997	215	995.6	3-5-84	996.6
4	Dam Monolith	40'	80.16	997	214	995.6	3-5-84	995.6
5	Dam Monolith	45'	98.30	989	213	987.4	3-5-84	987.4
6	Dam Monolith	35'	98.30	989	201 212	987.4	3-15-84	987.4
7	Dam Monolith	35'	100.54	985	211	985	3-15-84	985
8	Dam Monolith	35'	100.54	985	202	985	3-15-84	985
9	Dam Monolith	45'	100.54	985	210	985	3-15-84	985
17	Rt. Training Wall	26'	16.67	998	-	997.3	4-5-84	997.5
18	Rt. Training Wall	26'	21.00	998	-	997.3	4-5-84	997
19	Rt. Training Wall	26'	31.00	998	-	997.3	4-5-84	997
20	Lt. Training Wall	22.50'	16.00	998	-	996.8	4-5-84	998.3
21	Lt. Training Wall	22.50'	21.00	998	-	996.8	4-5-84	997.0
22	Lt. Training Wall	22.50'	31.00	998	-	996.8	4-5-84	996.8
--	Stilling Basin	105'	58.00	998	220 221	997±	phone 4-25-84	997.3
--	End Sill Key	105'	3.33	992	220 221	992	6-11-84	992
--	Stilling Basin Slab	105'	20.00	998±	-	-	6-11-84	998±

COMPUTATION SHEET

DATE

SUBJECT: FOUNDING ELEVATIONS - STONEWALL JACKSON DAM

COMPUTATION: STAGE II CONSTRUCTION

NO.

COMPUTED BY

CHECKED BY

Mono. No.	Description	Width Feet	Length Feet	TENTATIVE FOUND. ELEV.	EXPOR. BORING NO.	REVISED FOUND. ELEV.	REF. MEMO. DATE	AVE. FOUND ELEV.
10	Dam Monolith	40'	88.54	985	209	985	9-5-84	983.9
11	Dam Monolith	40'	88.54	987	208	985	9-5-84	985.1
12	Dam Monolith	40'	84.60	990	207,218 219	990	9-12-84	--
13	Dam Monolith	40'	76.69	1018	207 219	add. drilling	9-5-84	--
14	Dam Monolith	40'	55.35	1027	203 206	1027	9-5-84	1025.4
15	Dam Monolith	40'	45.09	1040	204	1040	9-5-84	1038.7
16	Dam Monolith	40'	29.29	1058	205	1060	9-5-84	1060
	ADDITIONAL 4 INCH DIAMETER BORINGS							
12	Dam Monolith	--	--	990	visual inspect	985	4-17-85	--
13	Dam Monolith	--	--	1018	222,223 224,225 226	1000	12-5-84	998.5
	ADDITIONAL 6 INCH DIAMETER BORINGS							
12	Dam Monolith	--	--	985	227,228 229,230 231	985	5-13-85	984.8

ORM FORM 437
7 DEC 44

10-01

"I"

CHRONOLOGICAL SEQUENCE OF CONSTRUCTION

Date	Event
01 Aug. 83	Start overburden excavation - lt. abutment
24 Aug. 83	Start rock anchor stabilization program
22 Sept 83	Start clearing on rt. abutment
26 Sept 83	Start presplit drilling for diversion channel
10 Oct. 83	Mobilize for fibercrete treatment in div. channel
21 Oct. 83	Divert river through diversion channel
06 Dec. 83	Excavate for concrete batch plant footers
17 Jan. 84	Mobilize on rt. abut. for 4" dia. explor. borings
22 Feb. 84	Presplit for retaining wall - rt. abutment
01 Mar. 84	Drill presplit for Monolith 1
10 Mar. 84	Drill presplit for Monolith 10
20 Mar. 84	Start spraying celtite 42-51 epoxy sealer on rock cuts
27 Mar. 84	Start installing chain link fabric on rock slopes
12 Apr. 84	Complete 4" dia. exploratory drilling program
16 Apr. 84	Clean found. Mono. 1; cover w/plastic & 6" sand
23 Apr. 84	Excavate sump in Mono. 10; 5 ft. below founding elevation
03 May 84	Clean and cover Monolith 2 foundation
23 May 84	Place crusher-run stone pad on stilling basin foundation
24 May 84	Start performance test on concrete mixer
25 May 84	Clean and cover Monolith 3 foundation
31 May 84	Fibercrete red clay seam at end of Monolith 16
04 June 84	Backfill sump in Mono. 9/10 found.; 24 cy conc.
04 June 84	Place 1st lift conc. in Mono. 21 (training wall)
05 June 84	Place 2 cy dental concrete in Monolith 9
06 June 84	Place 1st lift concrete in Monolith 9
08 June 84	Place 1st lift concrete in Monolith 22
12 June 84	Place 1st lift concrete in Monolith 7
15 June 84	22 cy plug concrete in Monolith 6
26 June 84	Install uplift cells in Monolith 5
27 June 84	Place 1st lift concrete in Monolith 5
03 July 84	Place 1st lift concrete in Monolith 3
07 July 84	Install uplift cells in Monolith 8
10 July 84	Place 1st lift concrete in Monolith 8
26 July 84	Place 1st lift concrete in Monolith 6
27 July 84	Place 1st lift concrete in Monolith 20
16 Aug. 84	Place 1st lift concrete in Monolith 4
06 Sept 84	Place 1st lift concrete in Monolith 2
22 Sept 84	Place 2 ft. material over Mono. 4 @ elev. 1012.5
04 Oct. 84	Drill and install anchors in stilling basin

11 Oct. 84	Mobilize for additional 4" explor. borings (Crown)
15 Oct. 84	Place 1st section of stilling basin floor
17 Oct. 84	Place 1st lift concrete in Monolith 1
01 Nov. 84	Place 1st lift concrete in Monolith 19
06 Nov. 84	Place 1st lift concrete in Monolith 18
08 Nov. 84	Place 1st lift concrete in Monolith 17
30 Nov. 84	Start line drilling for Monolith 15/16 face
06 Dec. 84	Place lt. side of stilling basin apron
13 Dec. 84	Place rt. side of stilling basin apron
21 Dec. 84	Shut down operations for holidays
07 Jan. 85	Continue operations
16 Jan. 85	Place impervious fill for u/s Stage II cofferdam
15 Feb. 85	Place impervious fill for d/s Stage II cofferdam
05 Mar. 85	Clean and cover Monolith 15 foundation
07 Mar. 85	Stage II diversion through Monolith 4
03 Apr. 85	Final production shot: Monoliths 10/11
05 Apr. 85	Drill stilling basin drain holes
15 Apr. 85	Compl. drilling & backfill stilling basin drain holes
20 Apr. 85	Place 1st lift concrete in Monolith 10
24 Apr. 85	Place 48 cy dental concrete in Monolith 11
01 May 85	Plae 1st lift concrete in Monolith 11
10 May 85	6" dia. explor. drilling in Mono. 12: Motts & Sons
14 May 85	Complete 6" dia. exploratory drilling
17 May 85	Place 92 cy of dental concrete in Monolith 12
22 May 85	Install uplift pressure cells in Monolith 12
24 May 85	Place 1st lift concrete in Monolith 12
07 June 85	Place 1st lift concrete in Monolith 13
11 July 85	Place 1st lift concrete in Monolith 14
19 July 85	Place 1st lift concrete in Monolith 15
08 Aug. 85	Place rt. abutment training wall
16 Aug. 85	Place rt. abutment service rd. tie-in: conc. plug
20 Sept 85	Place 1st lift concrete in Monolith 16
27 Sept 85	Clean-up stilling basin
10 Oct. 85	Divert river through dam sluices
03 Nov. 85	Rain: start of high water period
09 Jan. 86	Start grout curtain program: drainage gallery
08 Apr. 86	Start placing impervious plug for lt. abut. tie-in
04 June 86	Completed curtain grouting program
08 July 86	Start dismantling concrete batch plant
29 July 86	Last major concrete placement: pylon building

10-01

"J"

CURTAIN GROUTING

SUBJECT		PAGE
(1)	Equipment....................................	J-2 - J-11
(2)	Nomenclature.................................	J-12
(3)	Work Section: Hole Location..................	J-13 - J-14
(4)	Exploratory Borings..........................	J-15
(5)	Statistical Data.............................	J-16 - J-95

"J-1"

CURTAIN GROUTING

EQUIPMENT

DRILLS:

No.	Type	Model	Brand
1-4	Electric	COM-U	Craelus
1-4	Air	60	CP
1	Rotary	60	Mobile (surface holes)

BITS:

Type	Size	Use
Plug	1-1/2 in. (EX)	Grout holes
Drag	1-1/2 in.	Grout holes
Tricone	2-15/16 in.	Drain holes
Plug	2-7/8 in.	Drain holes
Diamond	3 in. (NX)	Drain holes
Diamond	3 in. (NX)	Exploratory

GROUT PLANTS:

No.	Capacity	Model	Brand
1	76 CF	Special made - dual tubs	
1	5.6 CF	CG-525-E	CemGrout

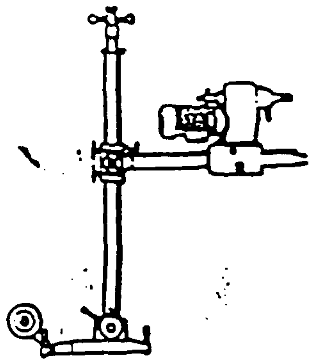
GROUT PUMPS:

No.	Capacity	Model	Brand
1	5.2 gal/100 rev.	3L6	MOYNO
1	18.8 gal/100 rev.	6P10	MOYNO

MISC.

1. Grout lines - 1-3/8 in. I.D.

2. Gages - 0-80 psi range
3. Water meter - American
4. Water source - West Fork River
5. Cement - Type I - 94 lb. bags (Lonestar)



Craelius

Spare parts list for

CDM Concrete drilling machine

Reservdelsförteckning för

CDM Betongborrningsmaskin

CONTENTS Page:

Concrete drilling machine CDM-U

Concrete drilling machine CDM-F

Concrete drilling machine CDM-Mini

Base, with tilt mechanism
Base, mini
Suction pad
Carriage assembly
Pivoting head assembly
Gear box

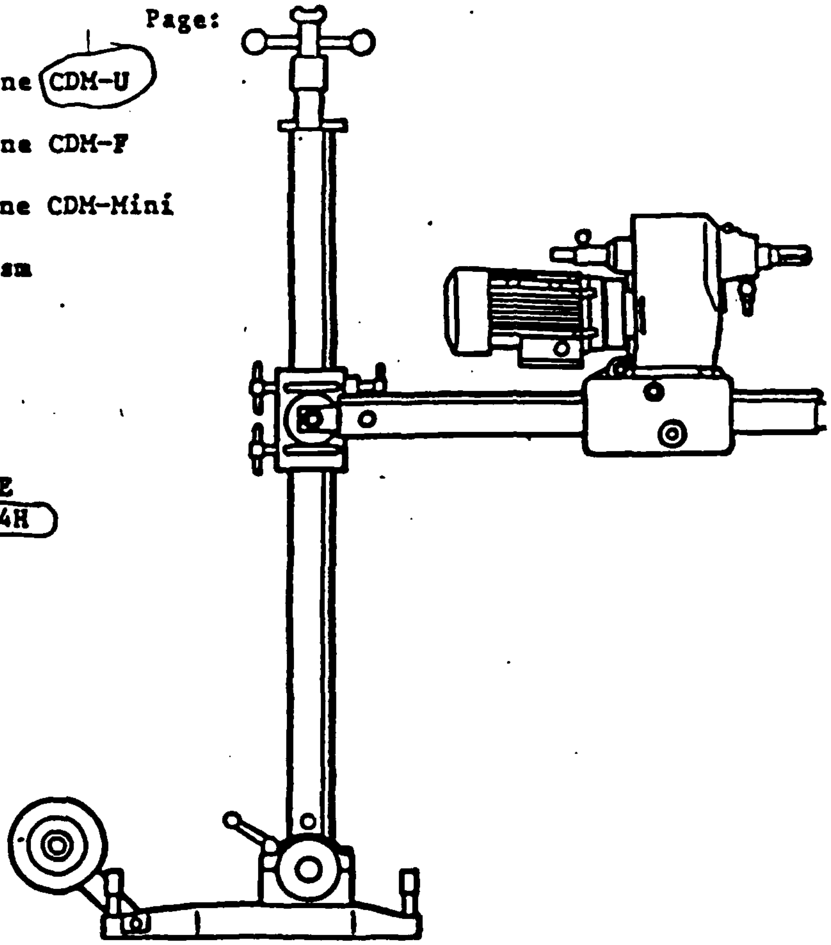
Drive unit, electric 44E
Drive unit, hydraulic 44H
Drive unit, air 44A
Drive unit, 22E

Hydraulic power pack

Pillar 1,5m ,compl.

OPTIONAL EQUIPMENT

Base with fixed taper
Crossbar support
Support legs
Pillars



DRILL USED FOR DRILLING GROUT & DRAIN HOLES.

MANUFACTURED BY

CHEMGROUT

LA GRANGE PK., ILL.

CG-525-E

S/N 85-689-3L6-E

ELECTRIC GROUT PLANT

OPERATING AND MAINTENANCE

INSTRUCTIONS

WITH

PARTS LIST

COMPONENT PARTS LIST

GROUT PUMP

Robbins & Myers, Moyno 3L6-CDR or CDQ

POWER TRANSMISSION COMPONENTS

Mixer Drive: Morse 18GCV, 15"1 right angle worm gear drive

Pump Sheave: Browning 2BK140 x/H x 3/4 bushing

Motor Sheave: Browning 2BK30 X 1-1/8

Drive Belts: Gates (or equal) 5L570

ELECTRICAL COMPONENTS

230/460 VAC THREE PHASE

Pump Drive Motor: Dayton 3N558, 5 H.P., 1740 RPM, NEMA 182T Frame. Full load amperage = 13.0 @ 230V, 6.5 @ 460V.

* Pump Motor Starter (230V.): Allen-Bradley 509-BDD (NEMA Size 00) with W55 heaters for 230V. and W47 heaters for 460V.

Mixer Drive Motor: Dayton 3N255F, 1 H.P., 1725 RPM, NEMA 56C Frame. Full Load Amperage: 4.6 @ 230V., 2.3 @ 460V.

* Mixer Motor Starter: Allen-Bradley 509-TOD (NEMA Size 00) with W45 heaters for 230V. and W37 heaters for 460V.

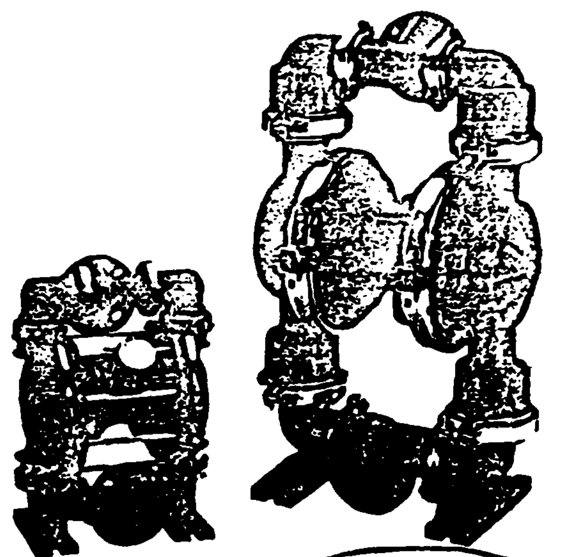
All other component parts as described on parts diagram, preceeding page.

* This unit is set for 230V 3-Phase. To change to 460V - 3-Phase, the coils and heaters in these starters must be changed.

The Wilden "Champ"

Available in Two Sizes

THE PUMP THE CHEMICAL PROCESS INDUSTRY HAS DEMANDED



M2 Champ
1" Flanged Inlet/Outlet

M8 Champ
2" Flanged Inlet/Outlet

A CORROSION-RESISTANT, SEALLESS, VIRTUALLY INDESTRUCTIBLE, INJECTION-MOLDED, SOLID . . .

PVDF OR POLYPROPYLENE WILDEN PUMP (Sump Pump)

The Wilden Champs operate on pressure to 100 psi with variable flow from 0 to 130 GPM. Broad application potential with special appeal to the chemical process industry.

- Self Priming
- High Suction Lift
- Can Run Dry
- Variable Speed & Pressure
- No Pressure Relief Required
- Sealless/Packingless Construction
- Easily Portable
- Low Maintenance
- Ferric Chloride
- Etching Solutions
- Planting Solution
- Acids/Bases
- Photo/Graphic Solutions
- Textile/Dye Solutions
- Solvents
- Pickling Solutions
- Aqua Regia
- Drum Pumping

"Our Business is making tough pumping jobs simple."

WILDEN PUMP® & ENGINEERING CO.

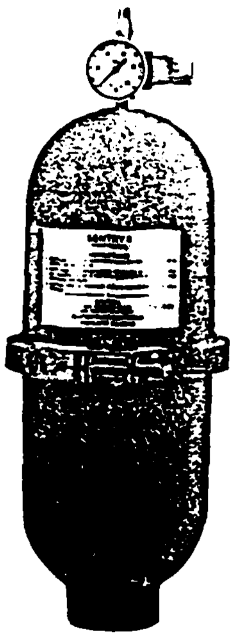
22069 Van Buren Street / Colton, CA 92324 / (714) 783-0621 / Telex (714) 676-452

RBG-S-12

BLACOH FLUID CONTROLS

SENTRY I

SURGE SUPPRESSOR



2" NPT-THD

Pat. Pend.

- **Removes up to 95% of pulsation**
- **Simple clamp band construction Allows easy replacement of working bladder**
- **Low cost broad chemical resistance**
- **Eliminate costly pipe system vibration and leakage**
- **Improve efficiency and life of expensive pumps and meters**

FINALLY — A unique solution for solving the inherent pulsation which accompanies reciprocating type pumps.

The Blacoh SENTRY I was specifically designed for low pressure applications (0 - 100 psig) with the increasingly popular and versatile air operated double diaphragm type pump.

The SENTRY I Surge Suppressor is truly unique. Constructed of a specially compounded, glass reinforced and UV stabilized thermoplastic. The working bladder provides high volumetric efficiency with the simplicity of a diaphragm held together with a simple clamp band for easy maintenance and inspection.

The SENTRY I is capable of handling a broad line of chemicals and abrasives at a much lower price than other suppressors in stainless steel or hastelloy.

The SENTRY I is operated and controlled by simply dialing the pressure needed on the high quality self-relieving pressure regulator.

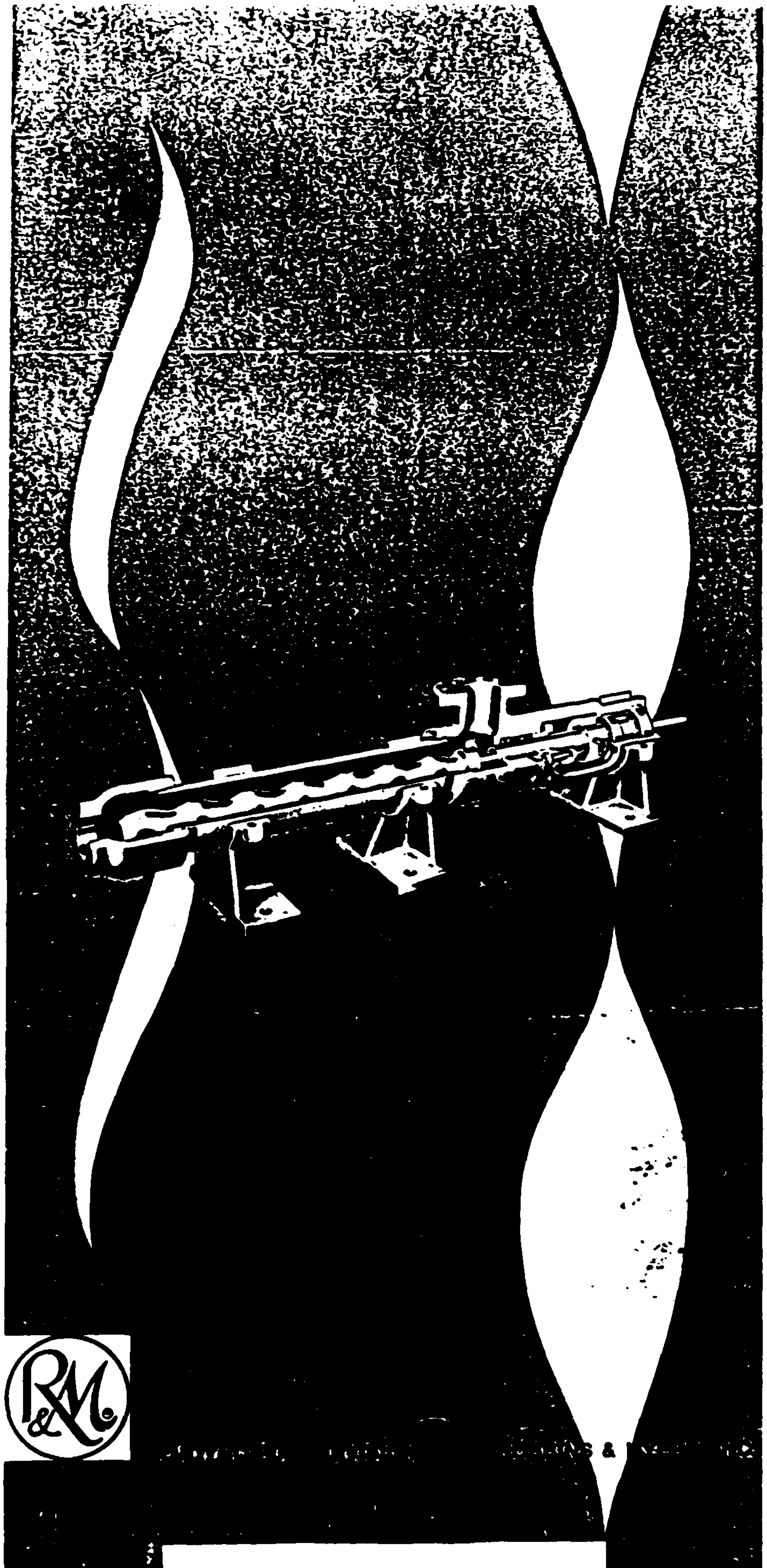
First, charge suppressor with full air line pressure, up to a maximum of 100 psig. *Next*, operate pump to generate working pressure. *Then*, gradually decrease air pressure in Sentry I until observed pulsation or vibration in system is minimized.

The SENTRY I comes standard with a neoprene bladder. Viton is available for high temperature and greater chemical resistance.

The SENTRY I has a maximum temperature limit of 150°F. PVDF is available for better corrosion resistance.

Distributed exclusively by Wilden Pump and Engineering Company through its authorized dealers.
WILDEN PUMP & ENGINEERING CO.
22069 Van Buren St.
Colton, CA. 92324
Ph. (714) 783-0621

BULLETIN



MOYNO.

PROGRESSING CAVITY

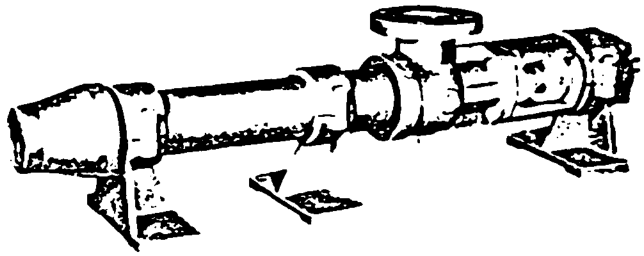
industrial pumps

...A TURN FOR THE BETTER

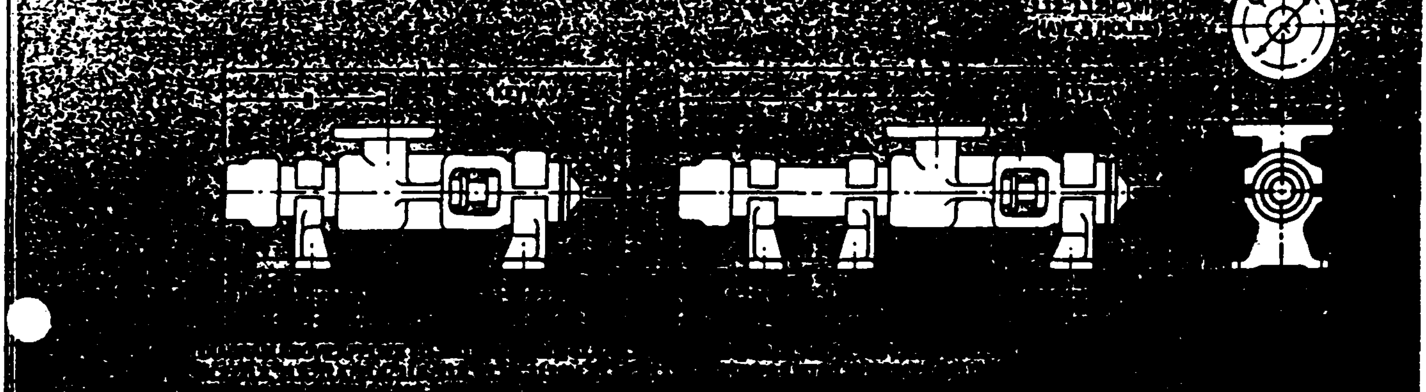
SPRINGFIELD, OHIO 45

FRAMES L, M and P

MOYNO pumps are most commonly specified in frame L designs. This is the standard frame construction suitable for the most frequently encountered pumping applications. Frames M and P are similar in design to frame L, but are equipped with heavy duty drive heads to accommodate greater horsepower for operation at higher pressures.



DIMENSIONS



PUMP SIZE	A*	B*	C	I*	L	WT. (Lbs.)	PUMP SIZE	A*	B*	C	I*	L	WT. (Lbs.)	PUMP SIZE	A*	B*	C	I*	L	WT. (Lbs.)
2M1	17	7 5/16	—	4	8 3/4	22	1L4	30	13 1/2	—	7 1/4	15 3/4	85	2L10	63 1/2	32 1/4	10 1/2	9 1/2	30	500
3M1	18 9/16	9 1/8	—	4 11/16	9 5/8	23 1/2	2L4	37 1/2	20 1/4	—	8 1/8	22	91	3L10	73 3/8	42 3/8	18	12 3/8	30	545
6M1	24 3/8	14 3/4	—	4 3/8	15 3/8	30	3L4	44 1/2	27 3/8	11	10 1/2	15 3/8	99	1L10H	58 1/2	27 1/8	—	15	30	424
1L2	17	7 5/16	—	4 1/4	8 1/2	22	6M4	71	49 3/8	25	17 5/16	20	171	2L10H	73 3/8	42 3/8	18	12 3/8	30	545
2L2	20 1/2	10 3/8	—	5 3/4	10 1/2	25	1L6	39 1/8	17 13/16	—	10 5/16	20	141	4P10H	115 3/8	75 3/8	16 1/2	11 1/4	33 3/4	1577
3L2	24 1/16	14 1/16	—	7 9/16	12	31	2L6	49 3/8	28 3/16	12	9 5/16	20	174	6P10	115 3/8	75 3/8	16 1/2	11 1/4	33 3/4	1577
6M2	39 1/8	26 3/8	14	7 9/16	11 1/2	55	3L6	60 3/8	39 5/16	18	13 13/16	20	192	1L12	70	31	—	14 1/2	37 1/2	880
1L3	22 3/8	10 1/8	—	5 5/16	11 1/2	47	1L8	46	20 5/16	—	9 3/4	27	303	2L12	85 1/2	46 1/2	20 1/2	12	35	1075
2L3	28 5/16	15 3/16	—	9 3/8	13	51	2L8	58 3/8	32 3/8	14	10 1/8	25	332	3L12	101 1/8	62 1/8	27	14 1/8	42	1200
3L3	33 3/8	20 3/8	9	7 3/16	11 1/2	59	3L8	70 13/16	45	24	12 5/16	25	372	1L12H	77 3/4	38 3/4	—	17 3/4	42	945
6M3	54 3/8	38	22	10 3/8	15 1/2	105	1L10	53 1/8	21 3/8	—	9 3/8	30	412	2L12H	101 1/8	62 1/8	27	14 1/8	42	1205

PUMP SIZE	DIMENSIONS																
	D**	E	F	G	H	J	K	M	N	O	P	Q	R	S	W	Z	Keyway
1L2, 2L2, 3L2, 2M1, 3M1, 6M1	3 1/4	5 3/8	3 1/8	2	3/8	3/8	2	4 1/4	1 1/2	3/16	3 1/8	3/8	4 1/4	—	4	3/16	3/16 x 3/32
1L3, 2L3, 3L3, 6M2	4 1/2	7 3/16	4 1/4	3	1/2	3/16	3	5	2 1/2	3/16	3 3/8	1/2	5 11/16	—	5 3/8	3/16	3/16 x 3/32
1L4, 2L4, 3L4, 6M3	5 1/2	9 3/8	5 1/2	3 1/2	9/16	3/16	3	7	3 1/8	3/8	5 1/2	5/8	7	—	7	11/16	1/4 x 1/8
1L6, 2L6, 3L6, 6M4	6 1/4	11 1/4	7	4	1 1/8	11/16	4	7 1/2	4 3/8	3/8	6	11/16	8 5/16	—	8 3/8	7/8	1/4 x 1/8
1L8, 2L8, 3L8	8	14	9	5	1 3/8	7/8	5	9	4 5/16	3/4	7 1/2	1 1/8	9 1/4	—	11 1/2	15/16	3/8 x 3/16
1L10, 2L10, 3L10, 1L10H, 2L10H	9 3/4	16 11/16	9	5	1 3/8	7/8	5	11	5 3/8	1/2	9 1/2	1 1/8	13 1/2	—	11 1/2	1	1/2 x 1/4
4P10H, 6P10	14	24	15 3/8	6	2 3/8	1	6	13 1/2	6	1/2	11 3/4	1 1/4	19	18 3/8†	17 1/2	1 1/8	3/8 x 3/16
1L12, 2L12, 3L12, 1L12H, 2L12H	12 1/2	21	12 3/8	6	2 1/4	1	6	13 1/2	6	1/2	11 3/4	1 1/8	18	—	14 1/2	1 1/8	1/2 x 1/4

Performance and Port Sizes — Frames L, M and P

Pump Frame	Gal./100 Rev.	Port Sizes		PUMP SPEED ●	300 RPM		450 RPM		600 RPM		800 RPM		1200 RPM	
		Vertical	Horiz.	Diff. Press. PSI	GPM	Min. HP	GPM	Min. HP	GPM	Min. HP	GPM	Min. HP	GPM	Min. HP
2M1	.056	1"	¾"	0 60 120			22 20 15	¼ ¼ ¼	.29 .26 .22	¼ ¼ ¼	43 41 37	¼ ¼ ¼	58 55 51	¼ ¼ ¼
3M1	.056	1"	¾"	0 90 180			.22 .20 .15	¼ ¼ ¼	.29 .26 .22	¼ ¼ ¼	.43 .41 .37	¼ ¼ ¼	.58 .55 .51	¼ ¼ ¼
6M1	.056	1"	¾"	0 180 360			.22 .19 .15	½ ½ ½	.29 .26 .22	¼ ¼ ¼	.43 .41 .37	½ ½ ½	.58 .55 .51	½ ½ ½
1L2	260	1"	¾"	0 30 60			1.1 .95	¼ ½	1.5 1.3 .9	½ ½ ½	2.2 2.1 1.7	½ ½ ½	3.0 2.8 2.3	½ ½ ½
2L2	260	1"	¾"	0 60 120			1.1 .95	½ ½	1.5 1.3 .9	¼ ¼ ½	2.2 2.1 1.7	½ ½ ½	3.0 2.8 2.3	½ ½ ½
3L2	260	1"	¾"	0 90 180			1.1 .95	½ ½	1.5 1.3 .9	½ ½ ½	2.2 2.1 1.7	½ ½ ½	3.0 2.8 2.3	½ ½ ½
6M2	260	1½"	¾"	0 180 360			1.1 .9	½ ½	1.5 1.3 .9	½ ½ ½	2.2 2.1 1.7	½ ½ ½	3.0 2.8 2.4	1 1 1
1L3	860	1½"	1¼"	0 40 75			3.8 3.0	½ ½	5.1 4.3 2.7	½ ½ ½	7.5 6.8 5.0	½ ½ ½	10. 9.3 7.7	½ ½ ½
2L3	860	1½"	1¼"	0 80 150			3.8 3.0	½ ½	5.1 4.3 2.7	½ ½ ½	7.5 6.8 5.0	½ ½ 1	10. 9.3 7.7	1 1 1½
3L3	860	1½"	1¼"	0 120 225			3.8 3.0	½ ½	5.1 4.3 2.7	½ ½ 1	7.5 6.8 5.0	½ 1 1½	10. 9.3 7.7	1 1½ 2
6M3	.860	2½"	1¼"	0 240 450			3.8 2.9	½ ½	5.1 4.3 2.7	1 1 1½	7.5 6.8 5.0	1½ 1½ 2	10.0 9.3 7.7	2 2 3
1L4	2.02	2½"	2"	0 40 75			9.0 6.7	½ ½	12.0 9.5 5.5	½ ½ ½	18 16 12	½ 1 1½	24 22 18	1 1 1½
2L4	2.02	2½"	2"	0 80 150			9.0 6.7	½ ½	12.0 9.5 5.5	½ 1 1½	18 16 12	1 1½ 2	24 22 18	1½ 2 3
3L4	2.02	2½"	2"	0 120 225			9.0 6.7	½ 1	12.0 9.5 5.5	1 1½ 2	18 16 12	1½ 2 3	24 22 18	2 3 3
6M4	2.02	3"	2½"	0 240 450			9.0 7.4	2 2	12 10 7	3 3 5	18 16 13	5 5 7½	24 22 19	5 5 7½
1L6	5.20	3"	2½"	0 40 75	15 11	1 1	23 19 13	1 1 1½	31 27 21	1½ 1½ 2	47 43 36	2 2 3		
2L6	5.20	3"	2½"	0 80 150	15 11	1 1	23 19 13	1½ 1½ 3	31 27 21	2 2 5	47 43 36	3 3 5		
3L6	5.20	3"	2½"	0 120 225	15 11	1½ 1½	23 19 13	2 3 5	31 27 21	3 3 5	47 43 36	5 5 7½		
1L8	11.7	4"	4"	0 40 75	33 27	2 2	51 45 35	2 2 3	68 62 52	3 3 5	100 94 84	5 5 7½		
2L8	11.7	4"	4"	0 80 150	33 27	3 3	51 45 35	3 5 7½	68 62 52	5 5 7½	100 94 84	7½ 7½ 10		
3L8	11.7	4"	4"	0 120 225	33 27	5 5	51 45 35	5 5 10	68 62 52	7½ 7½ 10	100 94 84	10 10 15		
1L10	18.8	6"	5"	0 40 75	56 46	2 2	84 74 53	3 3 5	115 105 84	5 5 7½				
2L10	18.8	6"	5"	0 80 150	56 46	3 5	84 74 53	5 7½ 10	115 105 84	7½ 7½ 15				
3L10	18.8	6"	5"	0 120 225	56 46	5 5	84 74 53	7½ 10 15	115 105 84	10 10 20				
1L10H	27.7	6"	5"	0 40 75	83 73	3 3	127 117 100	5 5 7½	168 158 143	7½ 7½ 10				
2L10H	27.7	6"	5"	0 80 150	83 73	5 5	127 117 100	7½ 7½ 15	168 158 143	10 10 20				
4P10H	27.7	8"	5"	0 175 350	80 70	15 15	128 118 96	25 25 40	168 158 137	30 30 50				
8P10	18.8	8"	5"	0 250 500	55 46	15 15	84 75 52	25 25 40	112 104 80	30 30 50				
1L12	43.5	8"	6"	0 40 75	130 118 85	5 7½ 10	196 184 149	7½ 10 15	261 248 216	10 15 20				
2L12	43.5	8"	6"	0 80 150	130 118 85	10 10 15	196 184 149	15 15 25	261 248 216	20 20 30				
3L12	43.5	8"	6"	0 120 225	130 118 85	15 15 25	196 184 149	20 20 30	261 248 216	25 25 50				
1L12H	65.2	8"	6"	0 40 75	185 173 123	7½ 7½ 15	293 272 220	10 15 20	391 373 321	15 15 25				
2L12H	65.2	8"	6"	0 80 150	185 173 123	15 15 25	293 272 220	20 20 30	391 373 321	25 25 50				

"J-2"

CURTAIN GROUTING

NOMENCLATURE

(1) Hole numbering sequence is related to its location or the direction of the hole angle: See Grout Curtain Cross Section for work sections.

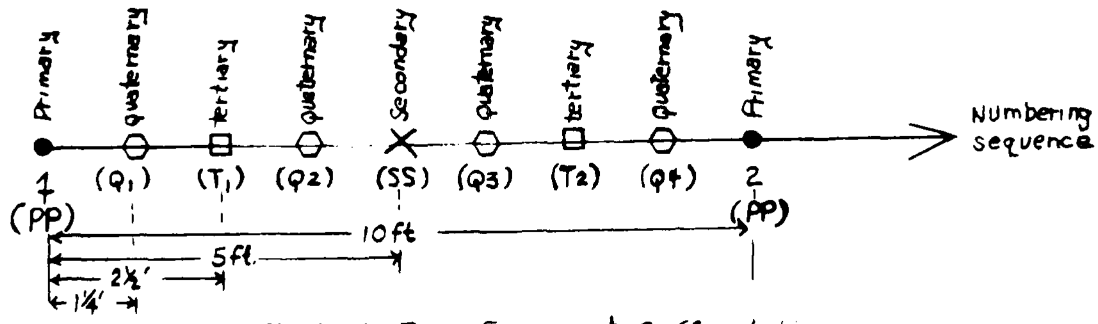
Number Prefix:

RR = Grout holes angled 20^{o} u/s and toward right abutment.
RF = Grout holes angled 20^{o} u/s and into the right abutment.
RS = Grout holes drilled from surface of right abutment.
LL = Grout holes angled 20^{o} u/s and toward left abutment.
LF = Grout holes angled 20^{o} u/s and into the left abutment.
LS = Grout holes drilled from surface of left abutment.
VV = Grout holes drilled vertically near a monolith joint.
LD = Special grout holes along Monolith 13 and 14 joint face.
GC = Exploratory NX core boring.

Number Suffix:

PP = Primary holes (1st series)
SS = Secondary holes (2nd series)
T No. = Tertiary holes (3rd series)
Q No. = Quarternary holes (4th series)

Note: Dual letters were used in prefix and suffix because of computer compatibility.
Example: Hole No. RR006SS was the sixth (006), secondary (SS) hole in the work section (RR) where grout holes were angled 20^{o} u/s and towards right abutment.



EXAMPLE: Spacing & Suffix lettering

"J-3"

CURTAIN GROUTING

1. WORK SECTIONS:

A. RIGHT ABUTMENT (work sequence 1,3,2,4, surface)

Station	Monoliths	Primary Hole No.
(1) 4+73.75 to 3+73.75	10-7	RR-001-PP to RR-011-PP
(2) 3+73.75 to 2+73.75	7-5	RR-011-PP to RR-021-PP
(3) 2+73.75 to 1+93.75	5-3	RR-021-S to RR-029-PP
(4) 1+93.75 to 1+26.75	3-1	RR-029-PP to RR-036-PP
Fan	1	RF-001-PP to RF-010-PP
(5) Surface	Rt. Abutment	RS-001-PP to RS-008-PP

B. LEFT ABUTMENT (work sequence 1,3,2, surface)

Station	Monoliths	Primary Hole No.
(1) 4+38.75 to 5+38.75	9-11	LL-001-PP to LL-011-PP
(2) 5+38.75 to 6+38.75	11-14	LL-011-PP to LL-021-PP
(3) 6+38.75 to 7+33.75	14-16	LL-021-PP to LL-030-PP
Fan	16	LF-001-PP to LF-009-PP
(4) Surface	Lt. Abutment	LS-001-PP to LS-011-PP

2. VERTICAL HOLES

No.	Station	Monolith
VV-001-PP	1+44	1
VV-002-PP	1+84	2
VC-004-PP	2+64	4
VC-013-PP	5+81	13
VC-014-PP	6+21	14
VC-015-PP	6+61	15
VC-016-PP	7+01	16

3. SPECIAL HOLES

No.	Station	Monolith
UD-001-PP	5+81 (4.5' d/s)	13
UD-002-PP	5+81 (2/5' d/s)	13
UD-003-PP	6+22.25 (4' d/s)	14

4. NX EXPLORATORY

No.	Station	Monolith
GC-1	1+11.50	surface rt. abutment
GC-2	1+62	2
GC-3	4+56	9
GC-4	5+70	12
GC-5	6+17	13
GC-6	1+98.75	3
GC-7	2+07.50	3
GC-8	7+51.50	surface lt. abutment

10-01

"J-5"

CURTAIN GROUTING

NX EXPLORATORY

HOLE NO.	LOCATION	INCINATION	T/H	B/H	DEPTH	P/T	DATE COMP.
GC-1	Right Abutment	Vertical	1102.00	995.9	106.1	1	05-08-86
GC-2	Gallery Mono. 2 Sta. 1+62	20^{o} u/s	1039.00	956.0	83.0	1	03-23-86
GC-3	Mono. 9 Sta. 4+56	Vertical	993.70	927.5	66.2	1	05-15-86
GC-4	Sta. 5+70	Vertical	1007.50	930.6	76.9	1	05-13-86
GC-5	Mono. 13 Sta. 6+17	Vertical	1032.50	945.1	87.4	1	05-12-86
GC-6	Sta. 1+98.75	Vertical	1005.00	994.5	10.5	1	05-27-86
GC-7	Sta. 2+07.50	Vertical	1005.00	994.5	10.5	1	05-27-86
GC-8	Sta. 7+51.50 4½' d/s	Vertical	1102.00	1010.0	92.0	1	05-30-86

"J-5"

CURTAIN GROUTING

STATISTICAL DATA

SUBJECT | PAGE

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INSTRUCTION REPORT GL-86-

MICROCOMPUTER GROUTING DATA PACKAGE: USER'S GUIDE

by

William E. Strohm, Jr.

Geotechnical Laboratory

DEPARTMENT OF THE ARMY
Waterways Experiment Station, Corps of Engineers
PO Box 631, Vicksburg, Mississippi 39180-0631

June 1986
Final Report

Prepared for

DEPARTMENT OF THE ARMY
US Army Corps of Engineers
Washington, DC 20314-1000

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20. ABSTRACT (Continue on second page if needed and identify by block no.) A data base package for storage, retrieval, and display of grouting data for geotechnical projects is described and detailed instructions for using the package are given. The data package is designed for storage, rapid retrieval, and display of grouting status, results, and progress. The package was developed using a purchased copy of dBASE III Data Base Management System (trademark of Ashton-Tate) on a microcomputer.		

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PREFACE

This user's guide describes the use of a data base package for storing and displaying grouting information and data on a microcomputer. The package is a product of the Computer Applications in Geotechnical Engineering (CAGE) project sponsored by the Office, Chief of Engineers (OCE), US Army. Criteria for a complete grouting data package were developed by a task group of Corps of Engineer (CE) District and Division representatives with experience on actual projects. Members of this group are Mr. John Albritton, Missouri River Division; Mr. Pete Hart, OCE; Mr. Lawson Jackson, Southwestern Division; Mr. Nels Jahren, St. Louis District; Mr. Dan Parrillo, South Pacific Division; Mr. Jerry Pritchard, Tulsa District; and Mr. Tod Riddle, Lower Mississippi Valley Division. The package reported in this guide was developed using the Stonewall Jackson Dam at Weston, West Virginia as a pilot project. Construction office personell provided data entry, operation of the programs, and made a number of valuable suggestions for improving data entry and for additional data summary plots and tables. Those involved were Mrs. Johnna Lowther, Civil Engineering Technician, Mr. Gordon Loudin, Assistant Resident Engineer, and David Nugen, geologist. Mr. William F. Woodburn was Resident Engineer and Mr. Pat Derell was the Huntington District Construction Engineer.

This report was prepared by Mr. W. E. Strohm, Jr., Engineering Geology and Rock Mechanics Division (EGRMD), Geotechnical Laboratory (GL), US Army Engineer Waterways Experiment Station (WES). Development of the CAGE package was carried out under the supervision of Dr. Don C. Banks, Chief, EGRMD, GL, and under the general supervision of Dr. William F. Marcuson III, Chief, GL. This report was edited by   , Publications and Graphic Arts Division.

The Commanders and Directors of WES during development of this data package and preparation of this user's guide were COL Robert C. Lee, CE and COL Allen F. Grum, USA; Technical Directors were Mr. Fred R. Brown and Dr. Robert W. Whalin.

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CONVERSION FACTORS, NON-SI TO SI (METRIC)
UNITS OF MEASUREMENT

Non-SI units of measurement used in this report can be converted to SI (metric) units as follows:

Multiply	by	To Obtain
feet	0.3048	metres
inches	2.54	centimetres
pounds (force) per square inch	6.894757	kilopascals
pounds (mass) per cubic foot	16.01846	kilograms per cubic metre

MICROCOMPUTER BORING AND SUBSURFACE DATA PACKAGE:

USER'S GUIDE

PART I: INTRODUCTION

Purpose

1. The purpose of this report is to provide a description and instructions for the use of the microcomputer version of the grouting information and data package entitled GROUT. The package was developed for Corps wide use under the Computer Applications in Geotechnical Engineering (CAGE) project. This report must be used in conjunction with other applicable instructions regarding the microcomputer operating system and instructions for creating and manipulation of a data base using a software package called dBASE III (trademark of Ashton-Tate).

Basic Definitions

2. A data base can be defined as items of information and groups of data values stored together in an orderly form such that access to all or any part of the information or data can be readily accomplished. Field grouting data forms with drilling, water pressure testing, and grouting data stored in a filing cabinet could be classified as a simple form of a data base. A computerized data base is one that utilizes a computer and associated hardware for data entry, storage, and access. A data base package includes, in addition to the data base itself, all peripheral software that enables the data not only to be quickly and orderly stored, but accessed, manipulated (or analyzed) by the most useful means, and displayed in the most useful manner for the user. A data base package can therefore be categorized as an engineering tool. It can, if properly utilized, be a powerful tool that greatly enhances the usefulness and value of geotechnical data.

Background

3. Criteria for a grouting data storage and display package were developed during 1984-85 by the grouting task group. The criteria covered design, construction control, and post construction operation use. A first priority was to provide a field construction control module for current projects. An initial data storage and summary table display package was developed using data on zone grouting furnished by the Los Angeles District for New River Dam. This initial version was used for demonstration purposes. In late 1985, the Huntington District in cooperation with their Stonewall Jackson Construction Office and the Pittsburgh District agreed to use the package as a pilot project during grouting beneath the Stonewall Jackson dam. This concrete gravity dam at Weston, West Virginia was nearly complete and grouting of the foundation from the gallery was to begin in early January 1986. Grouting was to be accomplished in two zones by the stage method. Field forms for collection of

drilling, water pressure testing, and grouting data were obtained and the grouting package was modified to meet the project forms and needs. Subsequent corrections and revisions suggested by the construction office were made as grouting progressed. The patience and cooperation of the field construction personnel were key elements in developing a timely and useful product.

Application

4. The grouting data base package, GROUT is intended to provide a convenient means for storing data from field grouting operations that can be used as a rapid aid in the following areas.

a. Monitoring the status of drilling and water pressure testing

b. Determining the need for grouting of stages and for split spacing of grout holes using project criteria.

c. Automatic calculation of estimated initial grout mixes and gage pressures when water pressure test data are entered.

d. Automatic calculation of sacks of cement used from grout mix and quantity values.

e. Monitoring the status of grouting and quick determination of permissible areas for drilling and pressure testing at the start of each shift.

f. Rapid display of summary tables and graphic display of pressure test water flow versus grout take for selected holes.

g. Automatic production of daily pay item summary table for comparison with contractor submitted quantities.

h. Display of progress, quantities, and costs for better assessment of likely overruns or potential problem areas.

Computer Requirements

5. The grouting data base programs have been written for use with dBASE III (trademark of Ashton-Tate) on a microcomputer using the MS-DOS operating system. The microcomputer should have a 20 megabyte hard disk to provide sufficient storage for a large number of grout holes. As a rough estimate, all data for one grout hole requires an average of about 5,500 bytes. A dot matrix printer is needed for simple plots and summary tables. Future graphics additions will require a large x-y plotter.

Report Organization

[illegible]. The remainder of this report is divided into two parts. Part II [illegible] data entry and storage and Part III describes display of data.

PART II: DATA ENTRY AND STORAGE

Data Base Structure

7. The proprietary software (dBASE III by Ashton-Tate) used to develop the microcomputer version of the grouting data package is a relational type of data base system. It uses a file structure that can be visualized as a table with columns for variables (called fields) and rows (records) for values of the variables. The structure for each data base file is created by naming the fields, defining their type (character or numeric) and their size (number of characters or digits and decimal places). The data in one file is related to the data in another file by key variables.

8. A diagram of the files for GROUT is shown in Figure 1. The related variables are hole number, zone, and stage. The type of data stored in each file is shown in Table 1. General data for the grout hole is stored in the first file (HOLEDAT.DBF) while specific data of the types shown in Table 1 are stored in the other files. The additional files listed in Table 1 are used to accumulate data from the main files and produce summary tables or graphic displays.

Data Entry

9. Data entry makes use of the full screen editing feature of dBASE III that allows a form to be shown on the monitor screen and filled in. The data entry segment of GROUT is menu driven. The main menu options, data entry forms, and submenu are shown in Figures 2, 3, and 4.

10. For a new grout hole, the basic data must be entered first into the HOLEDAT file with one record for each zone (menu option 1). The entered hole number is checked for a duplicate in the data already stored. If a duplicate is found, the user is requested to reenter the number. The record for the second zone is automatically created as an option. This file also includes pay item variables and these are automatically updated for each zone when the related data are later entered.

11. Once the hole data are entered, data for drilling, water pressure testing, or grouting can be entered in any order. For these options (2, 3, and 4, Figure 2), the hole number is asked for and checked. If it does not exist the user is given the choice of re-entering, seeing a list of hole numbers, or returning to the main menu. The zone and depth interval are asked for and the form is then shown on the screen with these items filled in. Additional entries for water pressure tests and grout injection data for the same hole and stage can be entered on the same screen as added lines. Pay item quantities are entered from the field forms for each stage when other entries in the form are completed. The grout pay item quantities are stored in a separate file (GPTSTG.DBF) and this file can be viewed and edited separately with option 5.

```
                         +------------+
                         :   GROUT    :   LHOLEDAT.DBF
                         : HOLE DATA  :
                         +-----+------+
                               :
                               :
          +----------------+-------+----------+----------------+
          :                :                  :                :
+----+-----+   +-------+---------+   +----+------+   +----+--------+
: DRILLING :   : WATER PRESSURE  :   : GROUTING  :   :  CONTRACT   :
: DATE AND :   : TEST DATA AND   :   :   DATA    :   : QUANTITIES  :
: PAY QUAN.:   : PAY QUANTITIES  :   +----+------+   : AND PRICES  :
+----------+   +-----------------+    LGRTLOG.DBF    +-------------+
LDRLRMKS.DBF      LWPLOG.DBF               :            LPAY.DBF
                                     +-----+-------+
All files are related to each other  : GROUT PAY   :
  by hole number, zone, and stage.   : QUANTITIES  :
                                     +-------------+
                                       LGRTSTG.DBF
```

Figure 1. Diagram of data base files for GROUT

GROUTING DATA BASE FOR STONEWALL JACKSON DAM PROJECT

MAIN MENU

TO ENTER NEW DATA OR REVIEW/EDIT EXISTING DATA	Selection
PROJECT AND GROUT HOLE DATA	1
DRILLING RECORDS	2
PRESSURE TEST DATA	3
GROUTING DATA	4
LIST PAY QUANTITIES FOR A GROUT STAGE	5
LIST OF GROUT MIXES & PRESSURES FOR RANGE OF HOLE NO'S.	6
PRINT HOLE STATISTICS	7
PRINT GROUTING REPORTS	8
RETURN TO OPERATING SYSTEM	9

Enter selection: 1

Copy of Selected Record

```
    Stonewall Jackson Lake: Grout Hole Data for One ZONE
PROJECT: STONEWALL JACKSON LAKE        LOCATION: Drainage Gallery - M 10

STATION: [illegible]          ELEVATION:  997.[illegible]        HOLE NO.: LL005FF

INCLINATION: [illegible]      DIAMETER: 1 1/2"           DEPTH NIPPLE: 1.[illegible]
DEPTH TO ROCK: [illegible]    PROPOSED DEPTH:  41.5      ACTUAL FINAL DEPTH:   [illegible]

DATE STARTED: [illegible]     DATE COMPLETED: [illegible]     ZONE: 1
DEPTH INTERVAL: 0.0-38.5            STAGES: [illegible]
DRILLED FOOTAGE:  41.1     PRESSURE TEST RATE:    [illegible]
GROUTING HOURS:   2.00     TAKE (PLACED):   [illegible]   WASTED:  1.00
 ------------------------------------------------------------------------
| TO ENTER NEW PROJ/HOLE DATA OR EDIT, REVIEW, OR PRINT EXISTING        |
|   1 = enter new data             4 = skip back one record             |
|   2 = edit data shown            5 = skip ahead one record            |
|   3 = select another record      6 = print a record      7 = exit     |
 ------------------------------------------------------------------------
        Enter selection number:
```

Figure 2. Main GROUT menu and drill hole data entry form with options

Copy of Selected Record

DRILLING LOG
INSPECTION: [illegible]

HOLE NO.: LL005PF

ZONE: 1   STAGE: 1   DRILL INTERVAL: 1.3-20.5

DATE: [illegible]

DRILL ACTION/REMARKS
BOTTOM OF STAGE 1

DRILLING FOOTAGE (GALLERY): 19.2
DRILLING FOOTAGE (SURFACE): 0.0
REDRILL FOOTAGE: 0.0

TO ENTER NEW DATA OR EDIT, REVIEW, OR PRINT EXISTING DATA
1 = enter new data   4 = skip back one record
2 = edit data shown above   5 = skip ahead one record
3 = select another record   6 = print a record   7 = exit

Enter selection number 7

Copy of Selected Record

PRESSURE TEST DATA

HOLE NO.: LL005PF

ZONE: [illegible]   STAGE: [illegible]   DEPTH INTERVAL: 1.3-20.5

DATE: [illegible]

FIELD TEST DATA

PRESSURE (P.S.I.)	INTERVAL (MIN)	TOTAL WATER	G.P.M.	REMARKS
[illegible]	[illegible]	3.97	0.79	CONNECT LL6P,LL7P,LL8P

TIME (MIN): 0.0   TIME (HRS): 0.00

TO ENTER NEW DATA OR EDIT, REVIEW, OR PRINT EXISTING DATA
1 = enter new data   4 = skip back one record
2 = edit data shown above   5 = skip ahead one record
3 = select another record   6 = print a record   7 = exit

Enter selection number 7

Figure 3. Data entry screens for drilling and waterpressure test data

```
                          Edit Record Shown

     Use arrow keys to move around,  or CTRL E, A, or S to back up
      CTRL D, F, or X to move ahead, RETURN to skip, CTRL W to end.

   GROUTING DATA                                   HOLE NO.: LL005FF

 ZONE: 1            STAGE:  1               DEPTH INTERVAL: 1.3-20.5
 DATE: 07/31/86

TIME  TANK   SACKS  TAKE   CF/MIN   W/C    PR             REMARKS
1747  0.60          1.82   0.18


  TO ENTER NEW DATA OR EDIT, REVIEW, OR PRINT EXISTING DATA
    1 = enter new data            4 = skip back one record
    2 = edit data shown above     5 = skip ahead one record
    3 = select another record     6 = print a record      7 = exit

                                      Enter selection number 7

                          Copy of Selected Record


   FINAL GROUT QUANTITIES                          HOLE NO.: LL005FF
                                             DEPTH INTERVAL: 1.3-20.5
 ZONE: 1            STAGE:  1
 DATE: [illegible]


                                   PLACING GALLERY (HOURS):    0.9[illegible]
                                   PLACING SURFACE (HOURS):    0.0[illegible]
                                     CEMENT GROUT (SACKS):     2.91
                                                 WASTE:        0.0[illegible]

  TO ENTER NEW DATA OR EDIT, REVIEW, OR PRINT EXISTING DATA
    1 = enter new data            4 = skip back one record
    2 = edit data shown above     5 = skip ahead one record
    3 = select another record     6 = print a record      7 = exit

                                      Enter selection number [illegible]
```

Figure 4. Data entry screens for grouting data

12. A major assumption for this stage grouting project was that only one record for drilling of each stage would be required and much of the data retrieval for summary tables is based on this assumption. Thus far this condition has been true. Redrilling (of grout) for subsequent stages when justified is entered as part of the subsequent stage drilling record.

13. The following capabilities during data entry are included in the package.

a. The true vertical depth for slant holes is automatically calculated and stored in the drilling data records (a cosine program using a cosine series was written, since dBASE III does not have this function).

b. Pay item quantities are automatically updated in the hole data records by zone when pertinent data is entered.

c. A table of estimated grout mixes and grout pressures is printed out for the range of project criteria when a drilling record is entered. Project criteria are based on water flow rates (cfm) from water pressure tests and the head of water from the spillway elevation ([illegible]).

d. When the water pressure record is entered for a hole stage, the initial [illegible] and calculated grout gage pressure are printed out.

14. The following restrictions apply.

a. All data entered can be edited. Consequently, if a hole number, or zone, or stage is changed for data stored in one file, then the corresponding records in the other files must be edited to change the same items.

b. No provision is included for deleting unwanted records. Thus if an unwanted record cannot be edited to become a desired record, knowledge of dBASE III and the index files used in the GROUT package is required to delete unwanted records form main and associated index files.

Data Storage

15. All data entered are stored in the appropriate file. A number of index files are used to keep the data ordered by hole number, zone, and stage or by date or other variable for rapid retrieval of data. This use of index files speeds up the operation of the grouting data package, but requires some additional disk space. A list of the index files and the key index variables is shown in Table 2.

16. Based on the data for Stonewall Jackson Dam at the time of this report, some 127 grout holes required approximately 597,5[illegible] bytes of storage. This amounts to about 4,69[illegible] bytes per hole. All data stored for New River Dam, Arizona required approximately 1,422,37[illegible] bytes for some 2[illegible] holes or [illegible] bytes per hole.

PART III: DATA RETRIEVAL AND DISPLAY

General

17. Data retrieval and display are done automatically using the selections shown on the menus in Figures 4 and 5. The two selections (options 6 and 7) of the main menu, Figure 4 are for a list of initial grout mixes and pressures for a range of hole numbers to be grouted and for statistical results. The statistical selection has three options, footage drilled and grout take per foot of hole by hole type and by individual holes, and a bar graph of vertical footage drilled and grout take. The report menu in Figure 5 includes summary tables and one graphic display of water flow versus grout take (in sacks) for a desired range of holes. Examples of the tables and plots are shown in Appendix A.

Summary Reports

18. The summary report selections are keyed to a hole number(s) or range. Option 1 in Figure 5 is intended to provide all data for one hole by time and stage for one or a range of hole numbers. Option 2 is intended to give the status for each hole in the desired range showing key results and date of drilling, pressure testing and grouting. This listing should aid in selecting permissible areas for drilling or pressure testing or grouting in accordance with the project criteria. Selection 3 provides a list of water flow and grout take by hole number and stage for a desired range of hole numbers and depth interval to summarize this data for a horizontal interval. Selection 4 is discussed below. Selection 5 and 6 produce a summary of pay quantities according to the project form for one date or for a desired range of dates. Selection 7 provides a quick listing of all pay quantity data accumulated in the hole data file to the current date.

Plot of Flow Versus Sacks

19. Selection 4 displays water pressure flow and grout take in sacks on 10 stick lines per page by station and hole number for the hole number range required. Each line represents a hole and at the bottom of each stage (true vertical scale of 1 in. = 10 ft) the water flow and grout take (sacks) are shown. If no grouting is required according to the criteria based on water flow, N-F is printed. If the take in a secondary hole reaches the threshold criteria for split spacing, an asterisk is printed. An option is provided to plot only secondary holes for a better review of the need for split spacing.

```
VERSION OF GROUT DATA BASE FOR STONEWALL JACKSON DAM, W.

     MENU FOR GROUTING REPORTS AND PLOT              Selection
==============================================      ---------
FIELD RECORDS FOR ONE ENTIRE HOLE - - - - - - - - - - - - - 1

DRILLING AND GROUTING SUMMARY FOR HOLE RANGE - - - - - - - 2

WATER & GROUT TAKE TABLE FOR HOLE AND DEPTH INTERVAL - - 3

PLOT OF FLOW VS SACKS FOR HOLE RANGE (BY STATION)  - - - 4

DAILY PAY ITEM RECORD FOR SELECTED DATE- - - - - - - - - 5

PAY ITEM RECORD SUMMARY FOR DATE RANGE - - - - - - - - - 6

PAY QUANTITY SUMMARY FROM PROJECT/HOLE FILE  - - - - - - 7

RETURN TO DATA ENTRY MENU - - - - - - - - - - - - - - - - 8

RETURN TO OPERATING SYSTEM - - - - - - - - - - - - - - - - 9

                              ENTER SELECTION: 5
```

Figure 5. Menu for report and display options

PART IV: RUNNING THE GROUT PACKAGE PROGRAMS

20. The GROUT data base package must be accessed using dBASE III software (until a compiled version is available). It is recommended that the GROUT data base package files be stored on a hard disk directory or subdirector, that can be accessed by dBASE III. Once dBASE III has been invoked and the path set to the GROUT data base files, the command to start the programs is 'DO GROUT' (do not enter quotes). At any time during execution of GROUT the escape key can be struck to exit to dBASE III and the program can be restarted with the above command. A copy of the programs is contained in Appendix B.

Table 1.

List of Grouting Data Base Files and File Structure

Structure for database : C:lholedat.dbf
Number of data records : 255
Date of last update : 05/01/86

Field	Field name	Type	Width	Dec
1	PROJ	Character	25	
2	LOCATION	Character	25	
3	STATION	Character	10	
4	TOPELEV	Numeric	7	2
5	HOLENO	Character	10	
6	ANGLE	Character	5	
7	HOLESIZE	Character	8	
8	DEPNIPPLE	Character	5	
9	DEPROCK	Character	5	
10	PROPDEP	Numeric	5	1
11	ZONE	Character	1	
12	TOTDEPTH	Numeric	5	1
13	DTESTART	Character	8	
14	DTECOMP	Character	8	
15	DEPINTER	Character	9	
16	STAGES	Numeric	2	
17	DRLFTG	Numeric	5	1
18	WPHOURS	Numeric	6	2
19	GRTHRS	Numeric	6	2
20	SACKS	Numeric	6	2
21	WASTE	Numeric	5	2
** Total **			167	

Structure for database : C:ldrlrmks.dbf
Number of data records : 293
Date of last update : 03/22/86

Field	Field name	Type	Width	Dec
1	HOLENO	Character	10	
2	ZONE	Character	1	
3	STAGE	Numeric	2	
4	DRLINT	Character	9	
5	ANGLE	Character	5	
6	DATE	Character	8	
7	DRLGLRY	Numeric	5	1
8	DRLSUFF	Numeric	5	1
9	REDFILL	Numeric	5	1
10	TRLDEPTH	Numeric	5	1
11	DRLELEV	Numeric	7	2
12	DRLRMKS	Character	25	
** Total **			88	

Continued

Table 1. (Continued)

Structure for database : C:lwplog.dbf
Number of data records : 359
Date of last update : 05/01/86

Field	Field name	Type	Width	Dec
1	HOLENO	Character	10	
2	ZONE	Character	1	
3	STAGE	Numeric	2	
4	WPDEFINT	Character	9	
5	DATE	Character	8	
6	WPTOTAL	Character	5	
7	WPTIME	Character	6	
8	WPMETER	Character	5	
9	WPFLOW	Character	5	
10	WPPRES	Character	25	
11	WPMIN	Numeric	4	1
12	WPHOURS	Numeric	5	2
13	ESTMIX	Character	4	
14	GRTPRES	Numeric	5	1
** Total **			95	

Structure for database : C:lgrtlog.dbf
Number of data records : 2114
Date of last update : 05/01/86

Field	Field name	Type	Width	Dec
1	HOLENO	Character	10	
2	ZONE	Character	1	
3	STAGE	Numeric	2	
4	GRDEFINT	Character	9	
5	DATE	Character	8	
6	GRTTIME	Character	4	
7	TANK	Character	4	
8	CEMSACKS	Character	5	
9	GRTINJEC	Character	4	
10	GRTRATE	Character	4	
11	GRCUTMIX	Character	4	
12	TOTPRES	Character	5	
13	GRTPRES	Character	25	
** Total **			86	

Continued

Table 1. (Continued)

Structure for database : C:lortstg.dbf
Number of data records : 211
Date of last update : 05/01/86

Field	Field name	Type	Width	Dec
1	HOLENO	Character	10	
2	ZONE	Character	1	
3	STAGE	Numeric	2	
4	GRIEFINT	Character	9	
5	DATE	Character	8	
6	GRTHRSG	Numeric	6	2
7	GRTHRSS	Numeric	6	2
8	SACKS	Numeric	6	2
9	WASTE	Numeric	5	2
** Total **			54	

Structure for database : C:lpavitem.dbf
Number of data records : 7
Date of last update : 05/03/86

Field	Field name	Type	Width	Dec
1	ITEM	Character	8	
2	NAME	Character	30	
3	QUAN	Character	7	
4	UNIT	Character	7	
5	PRICE	Character	6	
6	AMOUNT	Character	10	
** Total **			69	

Structure for database : C:lortsum.dbf
Number of data records : 281
Date of last update : 04/01/86

Field	Field name	Type	Width	Dec
1	HOLENO	Character	10	
2	ZONE	Character	1	
3	STAGE	Numeric	2	
4	DEPINTER	Character	9	
5	WPTOTAL	Character	5	
6	WPMETER	Character	5	
7	WPFLOW	Character	5	
8	DATEPT	Character	8	
9	DATEGR	Character	8	
10	SACKS	Numeric	6	2
11	GRTPRES1	Character'	5	
12	GRTPRES2	Character	5	
13	GRTMIX1	Character	4	
14	GRTMIX2	Character	4	
** Total **			78	

(Continued)

Sheet 2 of 4

Table 1. (Concluded)

Structure for database : C:ltake.dbf
Number of data records : 77
Date of last update : 04/01/86

Field	Field name	Type	Width	Dec
1	HOLENO	Character	10	
2	STATION	Character	10	
3	TOPELEV	Numeric	7	2
4	CTRELEV	Numeric	7	2
5	BOTEL	Numeric	7	2
6	DEFINTER	Character	9	
7	WPFLOW	Character	5	
8	SACKS	Numeric	6	2
9	F	Numeric	1	
** Total **			63	

Structure for database : C:lpaydate.dbf
Number of data records : 76
Date of last update : 05/02/86

Field	Field name	Type	Width	Dec
1	HOLENO	Character	10	
2	ZONE	Character	1	
3	STAGE	Numeric	2	
4	DEFINTER	Character	9	
5	DATEDR	Character	8	
6	DRLGLRY	Numeric	5	1
7	DRLSURF	Numeric	5	1
8	REDRILL	Numeric	5	1
9	DATEPT	Character	8	
10	WPHOURS	Numeric	5	2
11	DATEGR	Character	8	
12	GRTHRSG	Numeric	6	2
13	GRTHRSS	Numeric	6	2
14	SACKS	Numeric	6	2
15	WASTE	Numeric	5	2
16	REMARKS	Character	15	
** Total **			105	

(Sheet 4 of 4)

Table 2

List of Main Data and Index File Names

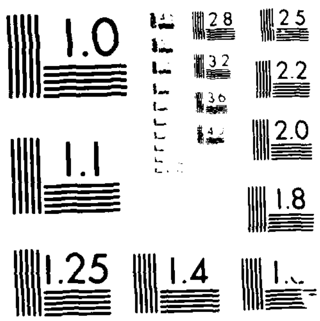
Data File	Index File	Key Index Variables
LHOLEDAT.DBF	LHOLEDAT.NDX	HOLENO+ZONE
LHOLEDAT.DBF	LHOLESTA.NDX	STATION+HOLENO
LDRLRMKS.DBF	LDRLRMKS.NDX	HOLENO+ZONE+STR(STAGE,2,0)
LDRLRMKS.DBF	LDRLDATE.NDX	DATE+HOLENO
LWPLOG.DBF	LWPLOG.NDX	HOLENO+ZONE+STR(STAGE,2,0)
LWPLOG.DBF	LWPDATE.NDX	DATE+HOLENO
LGRTLOG.DBF	LGRTLOG.NDX	HOLENO+ZONE+STR(STAGE,2,0)+DATE+GRTTIME
LGRTSTG.DBF	LGRTSTG.NDX	HOLENO+ZONE+STR(STAGE,2,0)
LGRTSTG.DBF	LGRTDATE.NDX	DATE+HOLENO
LGRTSUM.DBF	LGRTSUM.NDX	HOLENO+ZONE+STR(STAGE,2,0)
LTAKE.DBF	LTAKE.NDX	STATION+HOLENO
LPAYDATE.DBF	LPAHDATE.NDX	HOLENO

APPENDIX A

EXAMPLES OF TABLES AND PLOTS

AD-A191 144 FOUNDATION REPORT ON STONEWALL JACKSON DAM WEST FORK RIVER BASIN WESTON W. (U) CORPS OF ENGINEERS HUNTINGTON WV HUNTINGTON DISTRICT D NUGEN 21 DEC 87 2/6

UNCLASSIFIED DACW59-83-C-0053 F/G 13/2 NL



MICROCOPY RESOLUTION TEST CHART

LIST OF EST. GROUT MIXES AND PRESSURES BY STATION 06/04/86
FOR RANGE OF SPECIFIED HOLE NUMBERS LL003PP LL009PP

STATION	HOLENO	ZONE	STAGE	TOP OF HOLE ELEV.FT	STAGE BOTTOM ELEV.FT	FLOW CFM	EST. MIX RATIO	GROUT PRESS. PSI
4+58.75	LL003PP	1	2	993.75	955.45	0.02		0.0
4+58.75	LL003PP	2	1	993.75	935.85	0.05		0.0
4+58.75	RR002SS	1	1	993.75	957.35	0.42	4:1	55.8
4+58.75	RR002SS	2	1	993.75	935.85	0.03	N/R	0.0
4+63.75	LL003SS	1	1	993.75	954.95	0.08		0.0
4+63.75	RR002PP	1	1	993.75	980.55	0.26	4:1	49.2
4+63.75	RR002PP	1	3	993.75	955.45	0.17	4:1	59.3
4+63.75	RR002PP	2	1	993.75	935.85	0.08	N/R	0.0
4+68.75	LL004PP	1	1	993.75	954.95	0.14		0.0
4+68.75	LL004PP	2	1	993.75	935.85	0.06		0.0
4+68.75	RR001SS	2	1	993.75	935.85	0.09	N/R	0.0
4+73.75	LL004SS	1	1	993.75	954.95	0.33	4:1	56.7
4+73.75	LL004SS	2	1	993.75	935.85	0.23	4:1	64.0
4+73.75	RR001PP	1	2	993.75	977.75	1.2	1:1	47.3
4+73.75	RR001PP	1	3	993.75	955.45	0.26	4:1	59.3
4+73.75	RR001PP	2	1	993.75	935.85	0.04	N/R	0.0
4+78.75	LL005PP	1	2	993.75	955.45	0.32	4:1	59.3
4+78.75	LL005PP	2	1	993.75	935.85	0.10		0.0
4+81.25	LL005T1	1	1	994.00	980.00	0.01		0.0
4+81.25	LL005T1	1	3	994.00	960.10	0.17		0.0
4+83.75	LL005SS	1	1	994.00	955.20	0.27	4:1	56.6
4+83.75	LL005SS	2	1	994.00	936.10	0.02		0.0
4+86.25	LL005T2	1	1	994.00	980.00	0.01		0.0
4+88.75	LL006PP	1	2	994.00	955.70	0.08		0.0
4+88.75	LL006PP	2	1	994.00	936.10	0.31	4:1	67.0
4+91.25	LL006T1	1	1	994.00	980.00	0.03		0.0
4+91.25	LL006T1	1	2	994.00	960.10	0.09		0.0
4+93.75	LL006SS	1	1	994.00	955.20	0.02		0.0
4+93.75	LL006SS	2	1	994.00	936.10	0.05		0.0
4+96.25	LL006T2	1	1	994.00	980.00	0.08		0.0
4+96.25	LL006T2	1	2	994.00	960.10	0.16		0.0
4+98.75	LL007PP	1	2	994.00	955.70	0.02		0.0
4+98.75	LL007PP	2	1	994.00	936.10	0.09		0.0
5+01.25	LL007T1	1	1	994.00	980.50	0.01		0.0
5+01.25	LL007T1	1	2	994.00	960.10	0.04		0.0
5+03.75	LL007SS	1	1	994.00	955.20	0.01		0.0
5+03.75	LL007SS	2	1	994.00	936.10	0.10		0.0
5+06.25	LL007T2	1	1	995.00	980.50	0.04		0.0
5+06.25	LL007T2	1	2	995.00	960.30	0.05		0.0
5+08.75	LL008PP	1	2	997.00	958.70	0.01		0.0
5+08.75	LL008PP	2	1	997.00	939.10	0.02		0.0
5+11.25	LL008T1	1	1	998.75	980.95	0.07		0.0
5+11.25	LL008T1	1	2	998.75	960.45	0.10		0.0
5+13.75	LL008SS	1	1	1000.50	955.00	0.06		0.0
5+16.25	LL008T2	1	1	1002.50	983.10	0.07		0.0
5+16.25	LL008T2	1	2	1002.50	960.60	0.02		0.0
5+18.75	LL009PP	1	1	1003.50	955.00	0.21	4:1	58.5
5+18.75	LL009PP	2	1	1003.50	935.80	0.01		0.0

Figure A1. List of grout mixes and pressures, main menu, selection 6

CURTIN GROUTING STATISTICS

06/04/86

Sta. 4+38.75 to 5+18.75

Holes numbered LL001PP thru LL009PP

ZONE 1 (30 FT VERT.)

TYPE HOLE	NO. HOLES	DRILLING ROCK LF	SACKS PLACED	SACKS PER FT ROCK
Primary	9	390.7	35.88	0.09
Secondary	8	349.2	2.02	0.01
Tertiary	8	310.5	1.84	0.01
Quaternary	0	0.	0.	0.00
Misc.	0	0.	0.	0.00

ZONE 2 (20 FT VERT.)

TYPE HOLE	NO. HOLES	DRILLING ROCK LF	SACKS PLACED	SACKS PER FT ROCK
Primary	9	205.5	0.68	0.00
Secondary	8	175.2	1.91	0.01
Tertiary	0	0.	0.	0.00
Quaternary	0	0.	0.	0.00
Misc.	0	0.	0.	0.00

ZONE 1 & 2 TOTALS

TYPE HOLE	NO. HOLES	DRILLING ROCK LF	SACKS PLACED	SACKS PER FT ROCK
Primary	18	596.2	36.56	0.06
Secondary	16	524.4	3.93	0.01
Tertiary	8	310.5	1.84	0.01
Quaternary	0	0.	0.	0.00
Misc.	0	0.	0.	0.00
JOB TOTALS	42	1,431.1	42.33	0.03

Figure A2. Hole statistics by type of hole, main menu, selection 7

CURTIN GROUTING STATISTICS BY HOLE NUMBER   06/04/86

Range of Hole Numbers from : LL001PP to LL009PP
For Average sacks/ft value >=   0.01

HOLE NUMBER	STATION	SACKS PER FT	ELEV. OF MAJOR TAKES		
LL001SS	4+48.75	0.03	954.99	935.83	
LL002PP	4+53.75	0.01	964.17		
LL003PP	4+63.75	0.01	979.94		
LL004SS	4+78.75	0.03	954.99	935.83	
LL005PP	4+81.25	0.07	975.48	955.44	935.83
LL005T1	4+83.75	0.05	964.60	960.14	
LL005SS	4+86.25	0.01	955.24		
LL006PP	4+91.25	0.23	976.63	955.69	936.08
LL007PP	5+01.25	0.27	978.85	955.69	936.08
LL008T2	5+18.75	0.01	983.08		
LL009PP		0.05	955.03	935.78	

Figure A3. Hole statistics by hole number, main menu, selection 7

BAR GRAPH OF VERTICAL DRILL DEPTH AND GROUT TAKE IN SACKS 06/04/86

HOLE NUMBER: LL001PP TO LL009PP

LEGEND: 1,2,3 = Stages Drilled. A,B,C = Stages for Sacks, Shows Nearest Whole Sack (min. = 0.5)

SCALE OF VERTICAL DEPTH (F) AND SACKS (S)

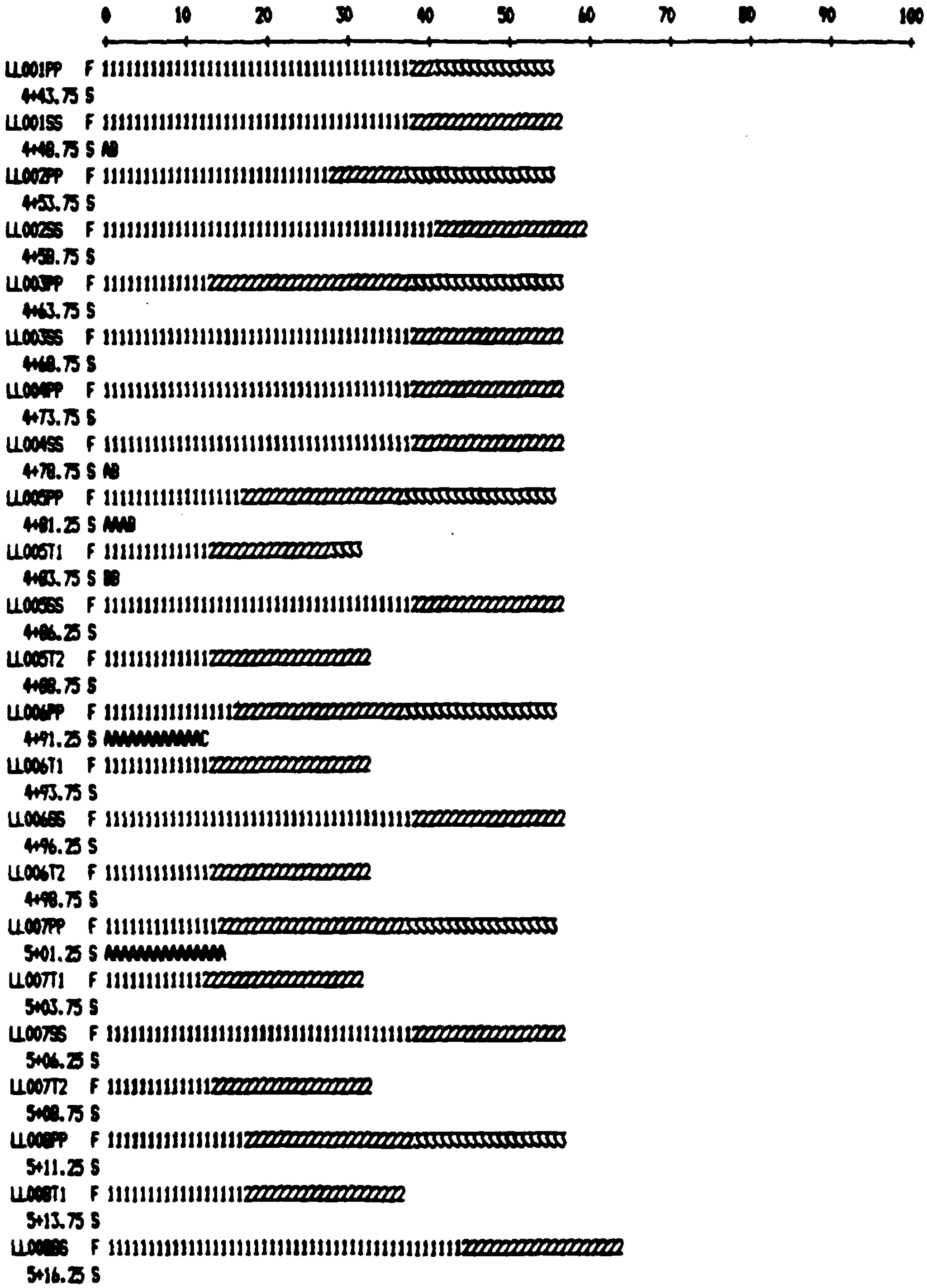


Figure A4. Hole statistics, bar graph, main menu, selection 7

06/04/86

FIELD GROUTING RECORD

PROJECT	LOCATION	STATION	INCLINATION	DIAMETER	DEPTH NIPPLE	ELEVATION	HOLE NO.
STONEWALL JACKSON LAKE	Drainage Gallery - M 10	4+78.75	27	1 1/2"	1.3'	993.75	LL005PP

ZONE: 1 STAGE: 1 DEPTH INTER.:1.3-20.5 DATES DRILLED:03/26/86 P. T.: 03/27/86 GROUTED: 03/31/86

DRILLING	PRESSURE TEST RECORD				GROUTING RECORD							
DRILL/PRESS TEST REMARKS	PRESS.	TIME	WATER	CFM	TIME	TANK	SACKS	TAKE	CFM	MIX	PRESS	REMARKS
BOTTOM OF STAGE 1					1625							CLOSE LL006PP
CONNECT LL6P,LL7P,LL8P	52.9	5.0	3.97	0.79	1727	1.37				2:1	52.1	CONNECT TO LL006PP
CLOSED LL6P,LL7P, LL8P	52.9	5.0	3.85	0.77	1728	1.23		0.45	0.45			
					1732	0.77		1.47	0.37			
					1732	1.54						
					1737	1.17		1.18	0.24			
					1747	0.60		1.82	0.18			
					1747	1.51						
					1757	1.12		1.24	0.12			
					1807	0.87		0.80	0.08			
					1817	0.79		0.26	0.03			
					1822	0.77		0.06	0.01			HOLDING 400 PSI

ZONE: 1 STAGE: 2 DEPTH INTER.:20.5-43.5 DATES DRILLED:04/02/86 P. T.: 04/03/86 GROUTED: 04/03/86

DRILLING	PRESSURE TEST RECORD				GROUTING RECORD							
DRILL/PRESS TEST REMARKS	PRESS.	TIME	WATER	CFM	TIME	TANK	SACKS	TAKE	CFM	MIX	PRESS	REMARKS
BOTTOM OF ZONE 1					0858	0.45	1.0			3:1	61.3	
	61.7	5.0	1.60	0.32	0859	0.33		0.38	0.38	3:1	61.3	
					0900	0.24		0.28	0.28	3:1	61.3	
					0904	1.35	1.0					CIRCULATE AND MIX
					0908	1.23		0.38	0.09	3:1	61.3	
					0913	1.12		0.35	0.07	3:1	61.3	
					0918	1.03		0.28	0.06	3:1	61.3	
					0923	0.94		0.28	0.06	3:1	61.3	
					0933	0.80		0.44	0.05	3:1	61.3	
					0943	0.67		0.41	0.04	3:1	61.3	
					0953	0.54		0.41	0.04	3:1	61.3	
					1003	0.48		0.19	0.02	3:1	61.3	HOLDING 350 PSI

ZONE: 2 STAGE: 1 DEPTH INTER.:43.5-65.9 DATES DRILLED:04/11/86 P. T.: 04/15/86 GROUTED: 04/15/86

DRILLING	PRESSURE TEST RECORD				GROUTING RECORD							
DRILL/PRESS TEST REMARKS	PRESS.	TIME	WATER	CFM	TIME	TANK	SACKS	TAKE	CFM	MIX	PRESS	REMARKS
BOTTOM OF ZONE 2					0000							GROUTING NOT REQUIRED
	70.2	5.0	0.52	0.10								

ZONE	STAGE	DEPTH INTER.	DATE	GALLERY HRS	SURFACE HRS	SACKS	WASTE
1	1	1.3-20.5	03/31/86	0.92	0.00	2.91	0.00
1	2	20.5-43.5	04/03/86	1.08	0.00	1.00	1.00

Figure A5. Complete field record for one hole, report menu, selection 1

STONEWALL JACKSON DAM, WV - FOUNDATION GROUTING SUMMARY HOLES: LL005PP TO LL007PP

HOLE NUMBER	STATION	ELEV. (ft)	ANGLE	ZONE	STAGE	DEPTH INTERVAL (ft)	PRESSURE TESTING PRESS (psi)	TOTAL (c f)	CFM (cfm)	DATE TESTED	GROUTING TAKE (sks)	PRESS. (psi)	MIX (W/C)	DATE GROUTED
LL005PP	4+78.75	993.75	27	1	1	1.3-20.5	52.9	3.85	0.77	03/27/86	2.91	52.1	2:1	03/31/86
												52.1	2:1	
				1	2	20.5-43.5	61.7	1.60	0.32	04/03/86	1.00	61.3	3:1	04/03/86
												61.3	3:1	
				2	1	43.5-65.9	70.2	0.52	0.10	04/15/86				NOT REQ.
LL005T1	4+81.25	994.00	27	1	1	1.3-15.7	46.0	0.07	0.01	04/24/86				NOT REQ.
				1	2	15.7-33.9	53.0	1.90	0.38	05/01/86	1.50			05/02/86
				1	3	33.9-38.2	54.6	0.86	0.17	05/05/86				NOT REQ.
LL005SS	4+83.75	994.00	27	1	1	1.3-43.5	56.7	1.37	0.27	04/07/86	0.43	56.2	3:1	04/08/86
												56.2	3:1	
				2	1	43.5-65.9	65.2	0.12	0.02	04/22/86				NOT REQ.
LL005T2	4+86.25	994.00	27	1	1	1.3-15.7	46.0	0.02	0.01	04/24/86				NOT REQ.
				1	2	15.7-38.2	54.6	0.36	0.07	05/01/86				NOT REQ.
LL006PP	4+88.75	994.00	27	1	1	1.3-19.5	52.5	11.52	2.30	03/27/86	12.28	52.9	2:1	03/31/86
												52.9	2:1	
				1	2	19.5-43.5	61.7	0.42	0.08	04/03/86				NOT REQ.
				2	1	43.5-65.9	70.2	1.53	0.31	04/15/86	0.68	70.3	3:1	04/15/86
												70.3	3:1	
LL006T1	4+91.25	994.00	27	1	1	1.3-15.7	46.0	0.13	0.03	04/24/86				NOT REQ.
				1	2	15.7-38.2	54.6	0.44	0.09	05/01/86				NOT REQ.
LL006SS	4+93.75	994.00	27	1	1	1.3-43.5	56.7	0.08	0.02	04/07/86				NOT REQ.
				2	1	43.5-65.9	65.2	0.27	0.05	04/22/86				NOT REQ.
LL006T2	4+96.25	994.00	27	1	1	1.3-15.7	46.0	0.38	0.08	04/24/86				NOT REQ.
				1	2	15.7-38.2	54.6	0.81	0.16	05/01/86				NOT REQ.
LL007PP	4+98.75	994.00	27	1	1	1.3-17.0	51.5	8.30	1.66	03/27/86	15.23	51.2	2:1	03/31/86
												51.2	2:1	
				1	2	17.0-43.5	61.7	0.12	0.02	04/03/86				NOT REQ.
				2	1	43.5-65.9	70.2	0.45	0.09	04/15/86				NOT REQ.

Figure A6. Drilling and grouting summary, report menu, selection 2
* Project Grouting Program Data in this report (p. 61-85)

06/04/86

PRESSURE FLOW AND GROUT TAKE FOR HOLE AND DEPTH RANGE SHOWN

HOLE RANGE: LL001PP - LL009PP
DEPTH RANGE: 15.0- 30.0

HOLE NO.	INTERVAL, FT	WATER CFM	TAKE, SKS	DATE PT	DATE GR
LL001PP	1.3-43.5	0.10	0.00	03/27/86	NOT REQ.
LL001SS	1.3-43.5	0.26	0.85	04/07/86	04/08/86
LL002PP	1.3-33.2	0.43	0.33	03/27/86	03/31/86
LL002SS	1.3-47.5	0.22	0.08	04/07/86	04/08/86
LL003PP	1.3-15.5	0.94	0.33	03/27/86	03/27/86
LL003PP	15.5-43.5	0.02	0.00	04/03/86	NOT REQ.
LL003SS	1.3-43.5	0.08	0.00	04/07/86	NOT REQ.
LL004PP	1.3-43.5	0.14	0.00	03/27/86	NOT REQ.
LL004SS	1.3-43.5	0.33	0.66	04/07/86	04/08/86
LL005PP	1.3-20.5	0.77	2.91	03/27/86	03/31/86
LL005PP	20.5-43.5	0.32	1.00	04/03/86	04/03/86
LL005SS	1.3-43.5	0.27	0.43	04/07/86	04/08/86
LL005T1	1.3-15.7	0.01	0.00	04/24/86	NOT REQ.
LL005T1	15.7-33.9	0.38	1.50	05/01/86	05/02/86
LL005T2	1.3-15.7	0.01	0.00	04/24/86	NOT REQ.
LL005T2	15.7-38.2	0.07	0.00	05/01/86	NOT REQ.
LL006PP	1.3-19.5	2.30	12.28	03/27/86	03/31/86
LL006PP	19.5-43.5	0.08	0.00	04/03/86	NOT REQ.
LL006SS	1.3-43.5	0.02	0.00	04/07/86	NOT REQ.
LL006T1	1.3-15.7	0.03	0.00	04/24/86	NOT REQ.
LL006T1	15.7-38.2	0.09	0.00	05/01/86	NOT REQ.
LL006T2	1.3-15.7	0.08	0.00	04/24/86	NOT REQ.
LL006T2	15.7-38.2	0.16	0.00	05/01/86	NOT REQ.
LL007PP	1.3-17.0	1.66	15.23	03/27/86	03/31/86
LL007PP	17.0-43.5	0.02	0.00	04/03/86	NOT REQ.
LL007SS	1.3-43.5	0.01	0.00	04/07/86	NOT REQ.
LL007T1	1.3-15.1	0.01	0.00	04/25/86	NOT REQ.
LL007T1	15.1-38.2	0.04	0.00	05/01/86	NOT REQ.
LL007T2	1.3-16.3	0.04	0.00	04/25/86	NOT REQ.
LL007T2	16.3-39.3	0.05	0.00	05/01/86	NOT REQ.
LL008PP	1.3-19.9	1.86	0.15	03/27/86	03/31/86
LL008PP	19.9-43.5	0.01	0.00	04/03/86	NOT REQ.
LL008SS	1.3-51.1	0.06	0.00	04/07/86	NOT REQ.
LL008T1	1.3-20.0	0.07	0.00	04/25/86	NOT REQ.
LL008T1	20.0-43.5	0.10	0.00	05/01/86	NOT REQ.
LL008T2	1.3-21.8	0.07	0.34	04/25/86	04/25/86
LL008T2	21.8-47.7	0.02	0.00	05/01/86	NOT REQ.
LL009PP	1.3-54.4	0.21	3.65	03/27/86	03/31/86

Figure A7. Water and grout take table, report menu, selection 3
* Project Grouting Program Data in this report (p. 86-95)

05/27/86

STONEWALL JACKSON DAM
PLOT OF WATER PRESSURE TAKE (CFM) VERSUS GROUT TAKE (SACKS)

Elev.	LL001PP 4+38.75 992.59	LL001SS 4+43.75 992.59	LL002PP 4+48.75 992.59	LL002SS 4+53.75 992.59	LL003PP 4+58.75 992.60	LL003SS 4+63.75 992.59	LL004PP 4+68.75 992.59	LL004SS 4+73.75 992.59	LL005PP 4+78.75 992.60	LL005T1 4+81.25 992.85
995+										
990+										
985+										
980+					0.94# : 0.3					0.01 : N/R
975+									0.77# : 2.9	
970+										
965+										0.38# : 1.5
			0.43# : 0.3							
960+										0.17 : N/R
955+	0.10 : N/R	0.26# : 0.9	0.13 : N/R		0.02 : N/R	0.08 : N/R	0.14 : N/R	0.33# : 0.7	0.32# : 1.0	+
	0.10 : N/R			0.22# : 0.1						
950+										
945+										
940+										
	0.13 : N/R	0.27# : [illegible]	0.09 : N/R	0.25# : 0.1	0.05 : N/R	0.06 : N/R	0.06 : N/R	0.23# : 1.0	0.10 : N/R	
935+										

LEGEND: # = FLOW >= 0.2, + = SACKS > 5.0 (Excludes PP Holes)

VALUES SHOWN ARE ROUNDED TO NEAREST DECIMAL SHOWN

Figure A8. Plot of flow and sacks at bottom of stage, report menu, selection 4

06/04/86

FOUNDATION DRILLING AND GROUTING
Daily Pay Item Record

DATE: 02/20/86 TO 03/02/86

PROJECT: STONEWALL JACKSON DAM

SHIFT:

Item No. / Hole No.	68-c-1 Drill Grt. Hole Gallery (ft)	68-c-2 Drill Grt. Hole Surface (ft)	Redrill Grout Holes (ft)	68-e Drill Explor. (ft)	68-g Press. Testing (hr)	68-h-1 Placing Grout Gallery (hr)	68-h-2 Placing Grout Surface (hr)	68-i Cement in Grout (cu.ft.)	Waste (cu.ft.)	68-j Additional Grout Pipe (ea)	Remarks
GC002	83.0	0.0	0.0		0.00	0.00	0.00	0.00	0.00		
LL013PP	74.7	0.0	47.9		1.09	4.56	0.00	17.25	8.16		
LL014PP	73.3	0.0	2.0		0.34	2.55	0.00	70.55	0.00		
LL015PP	77.0	0.0	2.0		0.43	3.98	0.00	19.60	0.00		
LL016PP	73.8	0.0	2.0		0.43	4.10	0.00	18.65	0.00		
LL017PP	76.7	0.0	2.0		0.51	1.25	0.00	14.08	0.00		
LL018PP	74.5	0.0	2.0		0.34	1.58	0.00	10.92	0.00		
LL019PP	75.1	0.0	2.0		0.25	1.43	0.00	8.13	0.00		
LL020PP	69.1	0.0	2.0		0.51	1.27	0.00	26.39	14.38		
LL021PP	66.5	0.0	2.0		0.43	4.92	0.00	66.14	13.44		
RF001SS	61.5	0.0	0.0		0.51	1.25	0.00	3.26	0.00		
RF002SS	63.2	0.0	4.0		0.77	2.33	0.00	19.13	0.00		
RF003SS	63.0	0.0	2.0		0.87	3.59	0.00	13.12	0.00		
RF004SS	62.6	0.0	2.0		0.35	1.28	0.00	2.17	0.00		
RF005SS	62.6	0.0	2.0		0.35	1.83	0.00	3.48	0.00		
RF006SS	61.5	0.0	2.0		0.43	0.50	0.00	0.56	0.00		
RR030SS	74.8	0.0	0.0		0.34	0.75	0.00	1.44	0.00		
RR031SS	70.5	0.0	2.0		0.59	2.83	0.00	17.34	0.00		
RR032SS	70.0	0.0	2.0		0.59	0.33	0.00	0.64	0.00		
RR033SS	66.7	0.0	0.0		0.34	0.00	0.00	0.00	0.00		
RR034SS	65.5	0.0	0.0		0.35	3.05	0.00	9.70	0.00		
RR035SS	60.4	0.0	2.0		0.35	1.18	0.00	1.82	6.62		
RR036SS	58.5	0.0	2.0		0.35	0.77	0.00	1.11	0.00		
TOTALS	1584.5	0.0	83.9		10.52	45.33	0.00	325.48	42.60		

Figure A9. Pay item record for date range, main menu, selections 5 and 6

Page No. 1
06/04/86

STONE WALL JACKSON DAM
Grouting Data

PAY ITEM QUANTITIES ACCUM. TO DATE

HOLE NUMBER	STATION	ZONE	DATE STARTED	DATE COMPLETE	NO. STAGES	DRILL FT	PRESS. TEST HRS	GROUT HRS	GROUT SACKS	WASTE SACKS
GC001	1+11.50	0	05/12/86	05/12/86	1	107.0	0.00	0.00	0.00	0.00
GC002	1+62.00	0	02/26/86	02/26/86	1	83.0	0.00	0.00	0.00	0.00
GC003	4+56	0	05/16/86	05/16/86	1	62.5	0.00	0.00	0.00	0.00
GC004	5+70	0	05/16/86	05/16/86	1	77.1	0.00	1.65	4.00	0.00
GC005	6+17	0	05/16/86		1	87.8	0.00	1.62	13.60	1.00
LD001PP	5+81	1	04/03/86		1	29.7	0.00	0.00	0.00	0.00
LD002PP	5+81	1	04/03/86		1	29.2	0.17	0.00	0.00	0.00
LD003PP	6+22.25	1	04/15/86	04/17/86	1	34.2	0.17	0.63	0.80	0.00
LF001PP	7+32.73	1	03/12/86	03/26/86	1	12.7	0.59	2.22	10.30	0.00
LF001PP	7+32.73	2	04/16/86	04/18/86	1	21.6	0.17	2.33	22.18	0.00
LF001SS	7+32.56	1	04/08/86	04/08/86	1	37.4	0.17	1.47	5.18	0.00
LF001SS	7+32.56	2	04/22/86		1	21.4	0.17	0.00	0.00	0.00
LF002PP	7+32.89	1	03/12/86	03/26/86	2	36.4	0.51	0.25	0.40	0.00
LF002PP	7+32.89	2	04/16/86	04/17/86	1	21.3	0.17	0.00	0.00	0.00
LF002SS	7+33.27	1	04/08/86	04/08/86	1	37.5	0.26	0.42	0.72	0.00
LF002SS	7+33.27	2	04/22/86		1	21.3	0.26	0.00	0.00	0.00
LF003PP	7+33.70	1	03/12/86	03/26/86	2	36.4	0.51	0.42	0.55	0.00
LF003PP	7+33.70	2	04/16/86	04/17/86	1	21.3	0.17	0.00	0.00	0.00
LF003SS	7+34.22	1	04/08/86	04/08/86	1	37.5	0.17	0.17	0.10	0.00
LF003SS	7+34.22	2	04/21/86		1	21.3	0.17	0.00	0.00	0.00
LF004PP	7+35	1	03/10/86	03/26/86	2	38.1	0.51	2.15	9.85	0.00
LF004PP	7+35	2	04/16/86	04/17/86	1	21.2	0.17	0.00	0.00	0.00
LF004SS	7+35	1	04/03/86	04/08/86	1	38.1	0.22	0.48	0.71	0.00
LF004SS	7+35	2	04/21/86		1	21.2	0.26	0.00	0.00	0.00
LF005PP	7+35	1	03/07/86	03/27/86	2	37.5	0.34	0.50	1.17	0.00
LF005PP	7+35	2	04/16/86	04/17/86	1	21.3	0.17	0.00	0.00	0.00
LF005SS	7+35	1	04/03/86	04/08/86	1	37.0	0.17	0.17	0.09	0.00
LF005SS	7+35	2	04/21/86		1	21.3	0.17	0.00	0.00	0.00
LF006PP	7+35	1	03/07/86	03/27/86	2	36.7	0.34	0.83	1.66	0.00
LF006PP	7+35	2	04/15/86	04/17/86	1	21.4	0.17	0.00	0.00	0.00
LF006SS	7+35	1	04/03/86	04/09/86	1	37.0	0.26	1.42	2.98	0.00
LF006SS	7+35	2	04/21/86		1	20.8	0.17	0.00	0.00	0.00
LF007PP	7+35	1	03/07/86	03/26/86	2	37.0	0.34	0.00	0.00	0.00
LF007PP	7+35	2	04/15/86	04/17/86	1	21.1	0.17	0.00	0.00	0.00
LF007SS	7+35	1	04/03/86	04/08/86	1	37.3	0.17	0.00	0.00	0.00
LF007SS	7+35	2	04/21/86	04/23/86	1	21.3	0.17	1.00	1.43	0.00
LF008PP	7+35	1	03/07/86	03/27/86	2	38.0	0.34	1.67	2.65	2.81
LF008PP	7+35	2	04/15/86	04/17/86	1	21.9	0.17	1.33	7.07	0.00
LF008SS	7+35	1	04/03/86	04/09/86	1	39.1	0:17	2.02	3.63	1.03
LF008SS	7+35	2	04/21/86		1	22.4	0.17	0.00	0.00	0.00
LF009PP	7+35	1	03/07/86	03/26/86	2	41.0	0.42	1.50	3.43	0.00
LF009PP	7+35	2	04/15/86		1	23.1	0.17	0.00	0.00	0.00
LL001PP	4+38.75	1	03/25/86	03/27/86	1	42.2	0.17	0.00	0.00	0.00
LL001PP	4+38.75	2	04/11/86	04/17/86	2	26.6	0.34	0.00	0.00	0.00
LL001SS	4+43.75	1	04/04/86	04/07/86	1	42.2	0.26	0.67	0.85	0.00
LL001SS	4+43.75	2	04/17/86	04/22/86	1	22.4	0.26	1.00	0.78	0.00

Totals appear on last page of printed table

Figure A10. Pay quantity summary from project-hole file, main menu, selection 7

CURTIN GROUTING STATISTICS

04/21/87

Sta. 0+92 to 7+78.5

Holes numbered GC001 thru VV016PP

ZONE 1 (30 FT VERT.)

TYPE HOLE	NO. HOLES	DRILLING ROCK LF	SACKS PLACED	SACKS PER FT ROCK
Primary	114	4,629.00	790.49	0.17
Secondary	102	4,174.50	179.83	0.04
Tertiary	49	2,439.70	61.36	0.03
Quaternary	10	498.30	3.25	0.01
Misc.	8	0.00	22.60	NO CALC.

ZONE 2 (20 FT VERT.)

TYPE HOLE	NO. HOLES	DRILLING ROCK LF	SACKS PLACED	SACKS PER FT ROCK
Primary	85	1,804.80	637.92	0.35
Secondary	83	1,746.90	53.51	0.03
Tertiary	0	0.00	0.00	0.00
Quaternary	0	0.00	0.00	0.00
Misc.	0	0.00	0.00	0.00

ZONE 1 & 2 TOTALS

TYPE HOLE	NO. HOLES	DRILLING ROCK LF	SACKS PLACED	SACKS PER FT ROCK
Primary	114	6,433.80	1,428.41	0.22
Secondary	102	5,921.40	233.34	0.04
Tertiary	49	2,439.70	61.36	0.03
Quaternary	10	498.30	3.25	0.01
Misc.	8	0.00	22.60	NO CALC.
JOB TOTALS	283	*15,293.20	*1,748.96	0.11

* Does not include redrill.

* Does not include backfill or waste.

CURTIN GROUTING STATISTICS

04/21/87

Sta. 7+32.56 to 7+35

Holes numbered LF001PP thru LF009PP

ZONE 1 (30 FT VERT.)

TYPE HOLE	NO. HOLES	DRILLING ROCK LF	SACKS PLACED	SACKS PER FT ROCK
Primary	9	337.00	30.01	0.09
Secondary	8	298.70	13.41	0.04
Tertiary	0	0.00	0.00	0.00
Quaternary	0	0.00	0.00	0.00
Misc.	0	0.00	0.00	0.00

ZONE 2 (20 FT VERT.)

TYPE HOLE	NO. HOLES	DRILLING ROCK LF	SACKS PLACED	SACKS PER FT ROCK
Primary	9	193.90	29.25	0.15
Secondary	8	171.00	1.43	0.01
Tertiary	0	0.00	0.00	0.00
Quaternary	0	0.00	0.00	0.00
Misc.	0	0.00	0.00	0.00

ZONE 1 & 2 TOTALS

TYPE HOLE	NO. HOLES	DRILLING ROCK LF	SACKS PLACED	SACKS PER FT ROCK
Primary	9	530.90	59.26	0.11
Secondary	8	469.70	14.84	0.03
Tertiary	0	0.00	0.00	0.00
Quaternary	0	0.00	0.00	0.00
Misc.	0	0.00	0.00	0.00
JOB TOTALS	17	1,000.60	74.10	0.07

CURTIN GROUTING STATISTICS

04/21/87

Sta. 4+38.75 to 7+33.75

Holes numbered LL001PP thru LL030SS

ZONE 1 (30 FT VERT.)

TYPE HOLE	NO. HOLES	DRILLING ROCK LF	SACKS PLACED	SACKS PER FT ROCK
Primary	30	1,459.70	384.58	0.26
Secondary	30	1,454.90	94.63	0.07
Tertiary	36	1,779.50	39.36	0.02
Quaternary	6	325.40	3.25	0.01
Misc.	0	0.00	0.00	0.00

ZONE 2 (20 FT VERT.)

TYPE HOLE	NO. HOLES	DRILLING ROCK LF	SACKS PLACED	SACKS PER FT ROCK
Primary	30	616.60	385.73	0.63
Secondary	30	614.50	27.46	0.04
Tertiary	0	0.00	0.00	0.00
Quaternary	0	0.00	0.00	0.00
Misc.	0	0.00	0.00	0.00

ZONE 1 & 2 TOTALS

TYPE HOLE	NO. HOLES	DRILLING ROCK LF	SACKS PLACED	SACKS PER FT ROCK
Primary	30	2,076.30	770.31	0.37
Secondary	30	2,069.40	122.09	0.06
Tertiary	36	1,779.50	39.36	0.02
Quaternary	6	325.40	3.25	0.01
Misc.	0	0.00	0.00	0.00
JOB TOTALS	102	6,250.60	935.01	0.15

CURTIN GROUTING STATISTICS

04/21/87

Sta. 7+40.9 to 7+40.9

Holes numbered LS001PP thru LS001PP

ZONE 1 (30 FT VERT.)

TYPE HOLE	NO. HOLES	DRILLING ROCK LF	SACKS PLACED	SACKS PER FT ROCK
Primary	1	18.40	0.51	0.03
Secondary	0	0.00	0.00	0.00
Tertiary	0	0.00	0.00	0.00
Quaternary	0	0.00	0.00	0.00
Misc.	0	0.00	0.00	0.00

ZONE 2 (20 FT VERT.)

TYPE HOLE	NO. HOLES	DRILLING ROCK LF	SACKS PLACED	SACKS PER FT ROCK
Primary	0	0.00	0.00	0.00
Secondary	0	0.00	0.00	0.00
Tertiary	0	0.00	0.00	0.00
Quaternary	0	0.00	0.00	0.00
Misc.	0	0.00	0.00	0.00

ZONE 1 & 2 TOTALS

TYPE HOLE	NO. HOLES	DRILLING ROCK LF	SACKS PLACED	SACKS PER FT ROCK
Primary	1	18.40	0.51	0.03
Secondary	0	0.00	0.00	0.00
Tertiary	0	0.00	0.00	0.00
Quaternary	0	0.00	0.00	0.00
Misc.	0	0.00	0.00	0.00
JOB TOTALS	1	18.40	0.51	0.03

CURTIN GROUTING STATISTICS

04/21/87

Sta. 5+81 to 6+22.25

Holes numbered LD001PP thru LD003PP

ZONE 1 (30 FT VERT.)

TYPE HOLE	NO. HOLES	DRILLING ROCK LF	SACKS PLACED	SACKS PER FT ROCK
Primary	3	93.10	0.80	0.01
Secondary	0	0.00	0.00	0.00
Tertiary	0	0.00	0.00	0.00
Quaternary	0	0.00	0.00	0.00
Misc.	0	0.00	0.00	0.00

ZONE 2 (20 FT VERT.)

TYPE HOLE	NO. HOLES	DRILLING ROCK LF	SACKS PLACED	SACKS PER FT ROCK
Primary	0	0.00	0.00	0.00
Secondary	0	0.00	0.00	0.00
Tertiary	0	0.00	0.00	0.00
Quaternary	0	0.00	0.00	0.00
Misc.	0	0.00	0.00	0.00

ZONE 1 & 2 TOTALS

TYPE HOLE	NO. HOLES	DRILLING ROCK LF	SACKS PLACED	SACKS PER FT ROCK
Primary	3	93.10	0.80	0.01
Secondary	0	0.00	0.00	0.00
Tertiary	0	0.00	0.00	0.00
Quaternary	0	0.00	0.00	0.00
Misc.	0	0.00	0.00	0.00
JOB TOTALS	3	93.10	0.80	0.01

CURTIN GROUTING STATISTICS

04/21/87

Sta. 1+25 to 1+27.34

Holes numbered RF001PP thru RF010PP

ZONE 1 (30 FT VERT.)

TYPE HOLE	NO. HOLES	DRILLING ROCK LF	SACKS PLACED	SACKS PER FT ROCK
Primary	10	409.60	62.60	0.15
Secondary	9	365.00	34.91	0.10
Tertiary	0	0.00	0.00	0.00
Quaternary	0	0.00	0.00	0.00
Misc.	0	0.00	0.00	0.00

ZONE 2 (20 FT VERT.)

TYPE HOLE	NO. HOLES	DRILLING ROCK LF	SACKS PLACED	SACKS PER FT ROCK
Primary	10	231.20	215.67	0.93
Secondary	9	205.80	9.39	0.05
Tertiary	0	0.00	0.00	0.00
Quaternary	0	0.00	0.00	0.00
Misc.	0	0.00	0.00	0.00

ZONE 1 & 2 TOTALS

TYPE HOLE	NO. HOLES	DRILLING ROCK LF	SACKS PLACED	SACKS PER FT ROCK
Primary	10	640.80	278.27	0.43
Secondary	9	570.80	44.30	0.08
Tertiary	0	0.00	0.00	0.00
Quaternary	0	0.00	0.00	0.00
Misc.	0	0.00	0.00	0.00
JOB TOTALS	19	1,211.60	322.57	0.27

CURTIN GROUTING STATISTICS

04/21/87

Sta. 1+26.25 to 4+73.75

Holes numbered RR001PP thru RR036T1

ZONE 1 (30 FT VERT.)

TYPE HOLE	NO. HOLES	DRILLING ROCK LF	SACKS PLACED	SACKS PER FT ROCK
Primary	36	1,560.80	219.87	0.14
Secondary	36	1,570.60	32.95	0.02
Tertiary	13	660.20	22.00	0.03
Quaternary	4	172.90	0.00	0.00
Misc.	0	0.00	0.00	0.00

ZONE 2 (20 FT VERT.)

TYPE HOLE	NO. HOLES	DRILLING ROCK LF	SACKS PLACED	SACKS PER FT ROCK
Primary	36	763.10	7.27	0.01
Secondary	36	755.60	15.23	0.02
Tertiary	0	0.00	0.00	0.00
Quaternary	0	0.00	0.00	0.00
Misc.	0	0.00	0.00	0.00

ZONE 1 & 2 TOTALS

TYPE HOLE	NO. HOLES	DRILLING ROCK LF	SACKS PLACED	SACKS PER FT ROCK
Primary	36	2,323.90	227.14	0.10
Secondary	36	2,326.20	48.18	0.02
Tertiary	13	660.20	22.00	0.03
Quaternary	4	172.90	0.00	0.00
Misc.	0	0.00	0.00	0.00
JOB TOTALS	89	5,483.20	297.32	0.05

CURTIN GROUTING STATISTICS

Sta. 0+92 to 1+11.50 04/21/87

Holes numbered RS001PP thru RS008SS

ZONE 1 (30 FT VERT.)

TYPE HOLE	NO. HOLES	DRILLING ROCK LF	SACKS PLACED	SACKS PER FT ROCK
Primary	8	367.30	6.66	0.02
Secondary	8	289.70	0.00	0.00
Tertiary	0	0.00	0.00	0.00
Quaternary	0	0.00	0.00	0.00
Misc.	0	0.00	0.00	0.00

ZONE 2 (20 FT VERT.)

TYPE HOLE	NO. HOLES	DRILLING ROCK LF	SACKS PLACED	SACKS PER FT ROCK
Primary	0	0.00	0.00	0.00
Secondary	0	0.00	0.00	0.00
Tertiary	0	0.00	0.00	0.00
Quaternary	0	0.00	0.00	0.00
Misc.	0	0.00	0.00	0.00

ZONE 1 & 2 TOTALS

TYPE HOLE	NO. HOLES	DRILLING ROCK LF	SACKS PLACED	SACKS PER FT ROCK
Primary	8	367.30	6.66	0.02
Secondary	8	289.70	0.00	0.00
Tertiary	0	0.00	0.00	0.00
Quaternary	0	0.00	0.00	0.00
Misc.	0	0.00	0.00	0.00
JOB TOTALS	16	657.00	6.66	0.01

CURTIN GROUTING STATISTICS

04/21/87

Sta. 1+44 to 7+01

Holes numbered VV001PP thru VV016PP

ZONE 1 (30 FT VERT.)

TYPE HOLE	NO. HOLES	DRILLING ROCK LF	SACKS PLACED	SACKS PER FT ROCK
Primary	7	209.10	37.11	0.18
Secondary	0	0.00	0.00	0.00
Tertiary	0	0.00	0.00	0.00
Quaternary	0	0.00	0.00	0.00
Misc.	0	0.00	0.00	0.00

ZONE 2 (20 FT VERT.)

TYPE HOLE	NO. HOLES	DRILLING ROCK LF	SACKS PLACED	SACKS PER FT ROCK
Primary	0	0.00	0.00	0.00
Secondary	0	0.00	0.00	0.00
Tertiary	0	0.00	0.00	0.00
Quaternary	0	0.00	0.00	0.00
Misc.	0	0.00	0.00	0.00

ZONE 1 & 2 TOTALS

TYPE HOLE	NO. HOLES	DRILLING ROCK LF	SACKS PLACED	SACKS PER FT ROCK
Primary	7	209.10	37.11	0.18
Secondary	0	0.00	0.00	0.00
Tertiary	0	0.00	0.00	0.00
Quaternary	0	0.00	0.00	0.00
Misc.	0	0.00	0.00	0.00
JOB TOTALS	7	209.10	37.11	0.18

CURTIN GROUTING STATISTICS BY HOLE NUMBER

04/15/87

Range of Hole Numbers from : OC001 to VV016PP

For Average sacks/ft value of: 1.0

HOLE NUMBER	STATION	SACKS PER FT	ELEV. OF MAJOR TAKE		
RF004PP	1+25	4.190	1018.97	1013.62	
RF006PP	1+25	0.180	1049.57		
RF007PP	1+25	4.500	1045.37		
RR036PP	1+33.75	0.590	1021.20		
RR023PP	2+58.75	0.150	993.23		
RR005PP	4+38.75	0.350	974.79		
RR003PP	4+56	0.840	982.17	977.71	967.02
LL007PP	5+01.25	0.270	978.85		
LL012PP	5+53.75	0.520	973.71		
LL014PP	5+70	1.080	957.58	940.57	
LL021PP	6+43.75	1.130	977.80		
LL023PP	6+61	1.490	1034.78	1002.17	984.35
LL024PP	6+73.75	1.330	987.52		
LL029PP	7+23.75	2.230	1009.65		
LS004PP	7+55.8	1.560	1067.03		

STONEWALL JACKSON DAM, WV - FOUNDATION GROUTING SUMMARY HOLES: LD001PP TO VV016PP

HOLE NUMBER	STATION	ELEV. (ft)	ANGLE	ZONE	STAGE	DEPTH INTERVAL (ft)	PRESSURE TESTING PRESS (psi)	TOTAL (c f)	CFM (cfm)	DATE TESTED	GROUTING TAKE (sks)	PRESS. (psi)	MIX (W/C)	DATE GROUTED
RS005SS	0+92	1102.00	0	1	1	21.0-48.0	25.6	0.10	0.02	05/07/86				NOT REQ.
RS005PP	0+94.50	1102.00	0	1	1	21.0-82.0	40.3	0.88	0.18	05/02/86				NOT REQ.
RS007PP	0+96	1102.00	20	1	1	22.3-51.0	25.6	0.35	0.07	05/02/86				NOT REQ.
RS008SS	0+96	1102.00	45	1	1	29.7-44.5	18.5	0.22	0.04	05/07/86				NOT REQ.
RS004SS	0+97	1102.00	0	1	1	21.0-48.0	25.6	0.05	0.01	05/07/86				NOT REQ.
RS006SS	0+97	1102.00	15	1	1	21.7-49.6	25.6	0.44	0.09	05/07/86				NOT REQ.
RS008PP	0+97	1102.00	35	1	1	25.6-51.2	23.0	0.17	0.03	05/02/86				NOT REQ.
RS006PP	0+98	1102.00	10	1	1	21.3-48.7	25.6	0.04	0.01	05/02/86				NOT REQ.
RS007SS	0+98	1102.00	25	1	1	23.2-53.0	25.6	0.12	0.02	05/07/86				NOT REQ.
RS004PP	0+99.50	1102.00	0	1	1	21.0-82.0	40.3	0.77	0.15	05/02/86				NOT REQ.
RS003SS	1+02	1102.00	0	1	1	21.0-82.0	40.3	0.35	0.07	05/07/86				NOT REQ.
RS003PP	1+04.50	1102.00	0	1	1	21.0-82.0	40.3	2.31	0.46	05/02/86	6.66	50.1 55.0	2:1 3:1	05/02/86
RS002SS	1+07	1102.00	0	1	1	21.0-82.0	40.3	0.85	0.17	05/07/86				NOT REQ.
RS001PP	1+09.50	1102.00	10	1	1	21.3-62.9	31.6	0.21	0.04	05/02/86				NOT REQ.
RS002PP	1+09.50	1102.00	0	1	1	21.0-82.0	40.3	0.00	0.00	05/02/86				NOT REQ.
GC001	1+11.50	1102.00	0	0	0	0.0-107.0	0.00	0.00	0.00	05/12/86				NOT REQ.
RS001SS	1+11.50	1102.00	4	1	1	21.0-62.2	31.7	0.40	0.08	05/07/86				NOT REQ.

RF004PP	1+25	1051.07	53.53	1	1	1.3-12.4	21	0.09	0.02	02/12/86				NOT REQ.
				1	2	12.4-41.5	29	8.80	1.76	02/19/86	6.47	33.3	1:1	02/19/86
												33.3	1:1	
				2	1	41.5-54.4	31	7.04	1.41	03/05/86	144.98	35.69	1:1	03/07/86
												40.75	2:1	
				2	2	54.4-63.9	40.3	0.42	0.08	03/10/86				NOT REQ.
RF004SS	1+25	1051.58	58.18	1	1	1.3-41.5	31.3	1.89	0.38	02/25/86	0.78	29.4	3:1	02/26/86
												29.4	3:1	
				2	1	41.5-65.4	34.8	1.14	0.23	03/13/86	1.39	34.9	3:1	03/13/86
												34.9	3:1	
RF005PP	1+25	1052.00	62.91	1	1	1.3-11.7	20	3.59	0.72	02/12/86	2.52			02/13/86
				1	2	11.7-41.5	28	0.25	0.05	02/19/86				NOT REQ.
				2	1	41.5-63.9	36.4	4.94	0.99	03/05/86	3.59	36.12	1:1	03/06/86
												36.12	1:1	
RF005SS	1+25	1052.40	67.73	1	1	1.3-41.5	27.0	2.08	0.42	02/25/86	0.84	24.32	3:1	02/26/86
												24.32	3:1	
				2	1	41.5-63.9	30.4	1.62	0.32	03/13/86	2.64	30.3	3:1	03/13/86
												30.3	3:1	
RF006PP	1+25	1052.77	72.61	1	1	1.3-10.7	19	5.78	1.20	02/12/86	3.30			02/13/86
				1	2	10.7-41.0	25	0.31	0.00	02/19/86				NOT REQ.
				2	1	41.0-63.4	32.0	0.30	0.06	03/05/86				NOT REQ.
RF006SS	1+25	1053.12	77.54	1	1	1.3-40.4	23.7	1.87	0.37	02/25/86	0.16	19.1	3:1	02/26/86
												19.1	3:1	
				2	1	40.4-62.8	25.8	1.69	0.34	03/13/86	0.40	25.4	3:1	03/13/86
												25.4	3:1	
RF007PP	1+25	1053.45	82.51	1	1	1.3-13.2	20	2.22	0.55	02/12/86	0.18			02/13/86
				1	2	13.2-40.4	22	0.56	0.11	02/19/86				NOT REQ.
				2	1	40.4-62.8	24.54	7.06	1.41	03/05/86	35.12	27.28	1:1	03/06/86
												28.27	3:1	
RF007SS	1+25	1053.80	87.50	1	1	1.3-40.9	20.0	2.34	0.47	02/25/86	0.89	18.6	3:1	02/26/86
												18.6	3:1	
				2	1	40.9-63.4	21.2	1.35	0.27	03/13/86	1.35	21.5	3:1	03/13/86
												21.5	3:1	
RF008PP	1+25	1054.10	92.50	1	1	1.3-12.8	19	0.15	0.03	02/12/86				NOT REQ.
				1	2	12.8-41.6	19	5.90	1.18	02/19/86	15.21	2:1	0.17	02/19/86
												18.7	2:1	
				2	1	41.6-64.5	16.78	7.05	1.41	03/05/86	24.08	22.28	0.61	03/06/86
												23.10	2:1	

RF008SS	1+25	1054.45	97.49	1	1	1.3-21.5	17.5	0.70	0.14	02/25/86				NOT REQ.
				1	2	21.5-42.6	19.6	0.39	0.08	02/28/86				NOT REQ.
				2	1	42.6-66.2	16.3	0.52	0.10	03/13/86				NOT REQ.
RF009PP	1+25	1054.77	102.5	1	1	1.3-12.3	18.0	0.03	0.00	02/12/86				NOT REQ.
				1	2	12.3-43.7	16	4.24	3.45	02/19/86	16.34	15.3	1:1	02/19/86
												15.5	2:1	
				2	1	43.7-68.5	18.2	4.45	0.89	03/05/86	1.87	18.35	2:1	03/06/86
												18.35	2:1	
RF009SS	1+25	1055.13	107.4	1	1	1.3-45.4	18.5	2.42	0.48	02/25/86	0.34	5.4	3:1	02/26/86
												5.4	3:1	
				2	1	45.4-70.7	11	0.57	0.11	03/13/86				NOT REQ.
RF010PP	1+25	1055.50	112.3	1	1	1.3-13.3	17	1.08	0.27	02/12/86	0.57			02/13/86
				1	2	13.3-47.7	12	6.95	1.39	02/19/86	0.17	12.0	1:1	02/19/86
												12.0	1:1	
				2	1	47.7-74.4	12.6	4.95	0.99	03/05/86	5.19	12.46	2:1	03/06/86
												12.46	2:1	
RF003PP	1+25.36	1050.25	44.60	1	1	1.3-41.8	33	1.32	0.26	02/12/86	0.16			02/13/86
				2	1	41.8-64.2	43.8	3.02	0.60	03/05/86	0.84	44.06	3:1	03/06/86
												44.06	3:1	
RF003SS	1+25.79	1051.25	49.00	1	1	2.4-37.9	18.8	6.44	1.29	02/25/86	12.99	23.3	2:1	02/25/86
												23.3	2:1	
				1	2	37.9-43.0	30.5	0.02	0.01	02/28/86				NOT REQ.
				2	1	43.0-63.9	38.0	7.59	1.52	03/13/86	0.13	38.0	3:1	03/13/86
												38.0	3:1	
RR036SS	1+26.25	1050.25	27	1	1	1.3-38.8	30.3	0.07	0.01	02/25/86				NOT REQ.
				2	1	38.8-59.8	37.9	1.51	0.30	03/13/86	1.11	37.9	3:1	03/13/86
												37.9	3:1	
RF002SS	1+26.68	1051.25	40.34	1	1	2.4-38.2	16.6	6.53	1.31	02/25/86	18.91	1 34.	2:1	02/25/86
												34.5	382	
				1	2	38.2-43.2	32.7	0.01	0.00	02/28/86				NOT REQ.
				2	1	43.2-65.6	41.5	7.60	1.52	03/13/86	0.22	41.5	3:1	03/13/86
												41.5	3:1	
RF001PP	1+27.03	1050.25	30.61	1	1	1.3-41.5	36.6	8.90	1.78	02/19/86	17.13	37.9	2:1	02/13/86
												37.9	2:1	
				2	1	41.5-63.9	49.0	0.12	0.02	03/05/86				NOT REQ.
RF002PP	1+27.04	1051.25	36.27	1	1	1.3-43.0	37.0	4.10	0.82	02/19/86	0.55	38.4	2:1	02/13/86
												38.4	2:1	

				2	1	43.0-65.4	46.4	0.23	0.05	03/05/86				NOT REQ.
RF001SS	1+27.34	1051.25	32.42	1	1	2.4-41.5	34.3	0.21	0.04	02/25/86		3:1 4	0.38	03/13/86
												3:1 4	0.38	
				2	1	41.5-63.9	43.2	7.51	1.50	03/13/86	3.26	3:1 4	0.11	03/13/86
												43.6	3:1	
RR036T1	1+28.75	1050.25	27	1	1	1.3-60.3	38.5	0.25	0.05	03/18/86				NOT REQ.
RR036PP	1+31.25	1050.25	27	1	1	1.3-32.6	32.9	12.8	2.56	02/12/86	31.26	1:1	0.13	02/13/86
												32.6	2:1	
				1	2	32.6-39.6	35.3	0.15	0.00	02/19/86				NOT REQ.
				2	1	39.6-61.1	43.79	0.10	0.02	03/05/86				NOT REQ.
RR035T2	1+33.75	1050.25	27	1	1	1.3-61.7	39.1	0.50	0.10	03/18/86				NOT REQ.
RR035SS	1+36.25	1050.00	27	1	1	1.3-41.9	31.0	1.80	0.36	02/25/86	0.16	31.5	3:1	02/25/86
												31.5	3:1	
				2	1	41.9-61.7	38.6	2.60	0.52	03/13/86	1.66	38.6	3:1	03/13/86
												38.6	3:1	
RR035T1	1+38.75	1050.00	27	1	1	1.3-61.7	39.1	0.29	0.06	03/18/86				NOT REQ.
RR035PP	1+41.25	1050.00	27	1	1	1.3-45.7	37.5	6.49	1.29	02/12/86	0.78	37.8	2:1	02/13/86
												37.8	2:1	
				2	1	45.7-62.6	44.37	0.14	0.03	03/05/86				NOT REQ.
RR034T2	1+43.75	1050.00	27	1	1	1.3-61.7	39.1	0.43	0.09	03/18/86				NOT REQ.
VV001PP	1+44	1050.00	0	1	1	1.3-33.0	34.6	11.25	2.25	02/12/86	30.71	35.1	2:1	02/13/86
												35.1	2:1	
RR034SS	1+46.25	1050.00	27	1	1	1.3-49.9	34.1	1.90	0.38	02/25/86	0.90	34.5	3:1	02/25/86
												34.5	3:1	
				2	1	49.9-66.8	40.6	4.62	0.92	03/13/86	8.80	40.6	3:1	03/13/86
												40.6	3:1	
RR034T1	1+48.75	1048.00	27	1	1	1.3-60.2	43.5	0.36	0.07	03/18/86				NOT REQ.
RR034PP	1+51.25	1046.00	27	1	1	1.3-50.4	39.7	5.15	1.03	02/12/86	22.60	40.4	1:1	02/12/86
												40.8	2:1	
				2	1	50.4-67.0	46.05	0.05	0.01	03/05/86				NOT REQ.
RR033T2	1+53.75	1044.25	27	1	1	1.3-55.2	41.6	1.02	0.30	03/18/86				NO RECOR
RR033SS	1+56.25	1042.50	27	1	1	1.3-51.3	39.5	0.12	0.02	02/25/86				NOT REQ.

				2	1	51.3-68.0	46.1	0.25	0.05	03/13/86				NOT REQ.
RR033T1	1+58.75	1040.50	27	1	1	1.3-56.8	42.2	0.25	0.05	03/18/86				NOT REQ.
RR033PP	1+61.25	1039.00	27	1	1	1.3-52.2	45.4	2.80	0.56	02/12/86	3.45	45.4	2:1	02/12/86
												45.4	2:1	
				2	1	52.2-69.0	51.44	0.13	0.03	03/04/86				NOT REQ.
GC002	1+62.00	1039.00	20 US	0	0	0.0-83.0	0.00	0.00	0.00	02/26/86				NOT REQ.
RR032T2	1+63.75	1039.00	27	1	1	1.3-49.4	39.4	2.42	0.48	03/18/86	1.87	39.2	3:1	03/18/86
												39.2	3:1	
RR032SS	1+66.25	1038.00	27	1	1	1.3-38.2	21.6	6.65	1.33	02/25/86	0.64	35.7	2:1	02/25/86
												35.7	2:1	
				1	2	38.2-54.1	41.1	0.04	0.01	02/28/86				NOT REQ.
				2	1	54.1-71.3	47.3	0.07	0.01	03/13/86				NOT REQ.
RR032Q2	1+67.50	1037.00	27	1	1	1.3-47.1	38.0	0.06	0.01	03/20/86				NOT REQ.
RR032T1	1+68.75	1036.00	27	1	1	1.3-46.0	38.1	1.65	0.33	03/18/86	14.13	38.0	1:1	03/18/86
												38.6	3:1	
RR032Q1	1+70.00	1035.25	27	1	1	1.3-45.2	37.3	0.02	0.00	03/20/86				NOT REQ.
RR032PP	1+71.25	1034.75	27	1	1	1.3-54.2	46.2	6.68	1.33	02/12/86	20.10	46.5	2:1	02/12/86
												46.5	2:1	
				2	1	54.2-72.4	52.7	0.14	0.03	03/04/86				NOT REQ.
RR031Q4	1+72.50	1033.75	27	1	1	1.3-43.5	36.7	0.01	0.00	03/20/86				NOT REQ.
RR031T2	1+73.75	1032.75	27	1	1	1.3-47.4	38.6	1.62	0.32	03/18/86	6.00	38.7	1:1	03/18/86
												39.3	*	
RR031Q3	1+75.00	1031.75	27	1	1	1.3-42.3	36.2	0.13	0.03	03/20/86				NOT REQ.
RR031SS	1+76.25	1030.75	27	1	1	1.3-37.0	23.2	6.54	1.31	02/25/86	17.34	35.1	2:1	02/25/86
												35.1	2:1	
				1	2	37.0-53.8	46	0.08	0.02	02/28/86				NOT REQ.
				2	1	53.8-71.8	52.5	0.41	0.08	03/13/86				NOT REQ.
RR031T1	1+78.75	1029.00	27	1	1	1.3-38.2	35.1	0.79	0.16	03/18/86				NOT REQ.

RR031PP	1+81.25	1029.00	27	1	1	1.3-55.3	51.6	10.7	2.14	02/12/86	10.04	52.0	2:1	02/12/86
												52.0	2:1	
				2	1	55.3-73.3	58.1	0.17	0.03	03/04/86				NOT REQ.
VV002PP	1+84	1029.00	0	1	1	1.3-39.0	47.2	7.6	1.52	02/12/86	6.40	47.8	2:1	02/12/86
												47.8	2:1	
RR030SS	1+86.25	1028.90	27	1	1	1.3-58.1	47.3	4.33	0.87	02/25/86	1.44	47.2	2:1	02/25/86
												47.2	2:1	
				2	1	58.1-76.1	54.2	0.17	0.03	03/13/86				NOT REQ.
RR030T1	1+88.75	1027.00	27	1	1	1.3-41.5	45.9	0.50	0.10	03/31/86				NOT REQ.
RR030PP	1+91.25	1025.00	27	1	1	1.3-57.5	52.4	6.60	1.32	02/12/86	0.47	52.2	2:1	02/12/86
												52.2	2:1	
				2	1	57.5-75.5	59.13	0.74	0.15	03/04/86				NOT REQ.
RR029PP	1+93.75	1004.00	27	1	1	1.3-13.8	46.6	0.00	0.00	01/15/86				NOT REQ.
				1	2	13.8-40.0	58.3	0.13	0.03	01/23/86				NOT REQ.
				2	1	40.0-57.8	67.6	0.43	0.09	02/03/86				NOT REQ.
RR029T2	1+93.75	1023.00	27	1	1	1.3-37.0	44.2	0.75	0.15	03/31/86				NOT REQ.
RR029SS	1+96.25	1021.25	27	1	1	1.3-57.3	52.0	0.02	0.01	02/25/86				NOT REQ.
				2	1	57.3-75.3	58.9	0.05	0.01	03/13/86				NOT REQ.
GC006	1+98.75	1005.00	10 DS	0	0	0.0-10.5	44.4	0.78	0.15	05/28/86				NOT REQ.
RR028SS	1+98.75	1004.00	27	1	1	1.3-42.9	46.8	0.49	0.10	01/28/86				NOT REQ.
				2	1	42.9-60.7	58.7	0.81	0.16	02/05/86				NOT REQ.
RR028PP	2+03.75	1003.75	27	1	1	1.3-12.0	45.8	2.15	0.43	01/15/86	2.00	46.6	3:1	01/17/86
												46.6	3:1	
				1	2	12.0-43.4	59.8	0.37	0.07	01/23/86				NOT REQ.
				2	1	43.4-63.6	69.8	0.64	0.13	02/03/86				NOT REQ.
GC007	2+07.50	1005.00	10 DS	0	0	0.0-10.5	44.4	7.75	1.55	05/28/86	5.00			05/28/86
RR027SS	2+08.75	1003.75	27	1	1	1.3-43.9	47.2	0.22	0.04	01/28/86				NOT REQ.
				2	1	43.9-65.4	60.4	0.24	0.06	02/05/86				NOT REQ.

RR027PP	2+13.75	1003.50	27	1	1	1.3-11.5	45.6	0.16	0.03	01/15/86				NOT REQ.
				1	2	11.5-44.2	58.0	0.11	0.06	01/23/86				NOT REQ.
				2	1	44.2-65.7	70.6	0.11	0.02	02/03/86				NOT REQ.
RR026SS	2+18.75	1002.50	27	1	1	1.3-43.7	37.2	3.07	0.61	01/28/86	1.99	37.2	3:1	01/28/86
												37.2	3:1	
				2	1	43.7-65.1	60.4	0.32	0.06	02/05/86				NOT REQ.
RR026PP	2+23.75	1001.80	27	1	1	1.3-9.6	44.7	0.61	0.12	01/15/86	0.25	45	3:1	01/17/86
												45	3:1	
				1	2	9.6-43.2	59.7	0.12	0.02	01/23/86				NOT REQ.
				2	1	43.2-64.9	70.3	1.85	0.37	02/03/86	1.22	70.8	3:1	02/03/86
												70.8	3:1	
RR025SS	2+28.75	1001.75	27	1	1	1.3-43.9	37.2	0.03	0.00	01/28/86				NOT REQ.
				2	1	43.9-65.5	60.1	0.50	0.10	02/05/86				NOT REQ.
RR025PP	2+33.75	1001.75	27	1	1	1.3-9.4	44.7	6.07	1.21	01/15/86	3.50	45	3:1	01/17/86
												45	3:1	
				1	2	9.4-44.5	60.3	0.17	0.03	01/23/86				NOT REQ.
				2	1	44.5-65.9	70.7	0.21	0.04	02/03/86				NOT REQ.
RR024SS	2+38.75	1001.50	27	1	1	1.3-18.1	37.4	0.62	0.12	01/28/86				NOT REQ.
				1	2	18.1-44.8	47.6	0.79	0.16	01/31/86				NOT REQ.
				2	1	44.8-66.2	60.8	6.0	1.20	02/05/86	0.91	60.6	2:1	02/05/86
												60.8	3:1	
RR024PP	2+43.75	1001.50	27	1	1	1.3-9.5	44.7	0.00	0.00	01/15/86				NOT REQ.
				1	2	9.5-43.3	59.8	0.04	0.00	01/23/86				NOT REQ.
				2	1	43.3-66.8	71.0	0.21	0.04	02/03/86				NOT REQ.
RR023SS	2+48.75	1001.25	27	1	1	1.3-14.0	35.8	4.73	0.95	01/28/86	1.65	35.8	3:1	01/28/86
												35.8	3:1	
				1	2	14.0-46.6	48.3	0.95	0.19	01/31/86				NOT REQ.
				2	1	46.6-67.1	61.4	1.25	0.25	02/05/86	1.28	61.9	3:1	02/05/86
												61.9	3:1	
RR023PP	2+53.75	1001.25	27	1	1	1.3-9.0	44.5	5.7	1.14	01/15/86	7.00	45	3:1	01/17/86
												45	3:1	
				1	2	9.0-18.7	48.8	1.19	0.24	01/23/86				NO RECOR

				1	3	18.7-46.2	57.7	0.32	0.06	01/23/86				NOT REQ.
				2	1	46.2-67.6	71.3	2.4	0.48	02/03/86	2.00	72.1	3:1	02/03/86
												72.1	3:1	
RR022SS	2+58.75	1001.00	27	1	1	1.3-46.5	48.2	0.25	0.05	01/28/86				NOT REQ.
				2	1	46.5-67.9	61.0	0.75	0.15	02/05/86				NOT REQ.
RR022PP	2+63.75	1001.00	27	1	1	1.3-9.8	44.8	0.33	0.07	01/15/86	0.25	45.4	3:1	01/17/86
												45.4	3:1	
				1	2	9.8-47.0	61.4	0.91	0.18	01/23/86				NOT REQ.
				2	1	47.0-68.5	71.7	1.23	0.25	02/03/86	0.61	72.5	0	02/03/86
												72.5	0	
VV004PP	2+64.00	1001.00	0	1	1	1.3-18.6	38.4	0.61	0.12	01/31/86				NOT REQ.
RR021SS	2+68.75	999.25	27	1	1	1.3-45.6	57.9	0.31	0.06	02/14/86				NOT REQ.
				2	1	45.6-67.2	66.2	0.68	0.14	02/20/86				NOT REQ.
RR021PP	2+73.75	995.25	27	1	1	1.3-41.9	61.5	0.21	0.04	02/07/86				NOT REQ.
				2	1	41.9-63.3	69.7	0.46	0.09	02/19/86				NOT REQ.
RR020SS	2+78.75	994.50	27	1	1	1.3-41.8	56.4	0.03	0.01	02/14/86				NOT REQ.
				2	1	41.8-63.4	64.7	0.53	0.11	02/20/86				NOT REQ.
RR020PP	2+83.75	994.50	27	1	1	1.3-18.9	52.7	5.88	1.96	02/07/86	0.27	52.7	1:1	02/07/86
												52.7	1:1	
				1	2	18.9-41.9	61.5	0.10	0.02	02/10/86				NOT REQ.
				2	1	41.9-63.7	69.9	0.24	0.05	02/19/86				NOT REQ.
RR019SS	2+88.75	994.50	27	1	1	1.3-42.0	56.5	0.96	0.19	02/14/86				NOT REQ.
				2	1	42.0-64.1	65.0	7.95	1.59	02/20/86	0.08			02/21/86
RR019PP	2+93.75	994.25	27	1	1	1.3-41.8	61.0	9.80	1.96	02/07/86	3.54	61.0	1:1	02/07/86
												61.0	1:1	
				2	1	41.8-64.0	69.9	0.24	0.05	02/19/86				NOT REQ.
RR018SS	2+98.75	994.25	27	1	1	1.3-41.9	56.5	0.86	0.17	02/14/86				NOT REQ.
				2	1	41.9-64.1	65.0	5.03	1.01	02/20/86	0.79	65.1	2:1	02/21/86
												65.4	4:1	

RR018PP	3+03.75	994.25	27	1	1	1.3-42.0	61.5	0.30	0.06	02/07/86				NOT REQ.
				2	1	42.0-64.3	70.1	0.64	0.13	02/19/86				NOT REQ.
RR017SS	3+08.75	994.25	27	1	1	1.3-42.4	56.7	0.16	0.03	02/14/86				NOT REQ.
				2	1	42.4-64.4	65.1	0.85	0.17	02/20/86				NOT REQ.
RR017PP	3+13.75	994.00	27	1	1	1.3-27.1	55.8	1.57	0.31	02/07/86	0.90	55.8	2:1	02/07/86
												55.8	3:1	
				1	2	27.1-42.3	61.6	0.16	0.03	02/10/86				NOT REQ.
				2	1	42.3-64.3	70.1	0.70	0.14	02/19/86				NOT REQ.
RR016SS	3+18.75	994.00	27	1	1	1.3-42.5	56.7	0.04	0.01	02/14/86				NOT REQ.
				2	1	42.5-64.5	65.2	0.14	0.03	02/20/86				NOT REQ.
RR016PP	3+23.75	994.00	27	1	1	1.3-19.5	52.9	3.30	0.66	02/07/86	2.23	52.1	3:1	02/07/86
												52.1	3:1	
				1	2	19.5-42.5	61.7	0.24	0.05	02/10/86				NOT REQ.
				2	1	42.5-64.8	70.2	0.95	0.19	02/19/86				NOT REQ.
RR015SS	3+28.75	993.75	27	1	1	1.3-42.4	56.7	0.04	0.01	02/14/86				NOT REQ.
				2	1	42.4-64.7	65.2	0.84	0.17	02/20/86				NOT REQ.
RR015PP	3+33.75	993.75	27	1	1	1.3-42.5	61.7	0.62	0.12	02/07/86	0.23	62.4	3:1	02/07/86
												62.4	3:1	
				2	1	42.5-64.8	70.2	0.33	0.07	02/19/86				NOT REQ.
RR014SS	3+38.75	993.75	27	1	1	1.3-42.7	56.8	0.20	0.04	02/14/86				NOT REQ.
				2	1	42.7-64.9	65.3	0.77	0.15	02/20/86				NOT REQ.
RR014PP	3+43.75	993.75	27	1	1	1.3-28.6	56.4	4.36	0.87	02/07/86	4.86	56.6	3:1	02/07/86
												56.6	3:1	
				1	2	28.6-42.9	61.8	1.13	0.23	02/10/86	0.49	62.6	3:1	02/10/86
												62.6	3:1	
				2	1	42.9-65.0	70.3	0.25	0.05	02/19/86				NOT REQ.
RR013SS	3+48.75	993.75	27	1	1	1.3-43.2	57	0.68	0.14	02/14/86				NOT REQ.
				2	1	43.2-65.2	65.4	0.84	0.17	02/20/86				NOT REQ.
RR013PP	3+53.75	993.75	27	1	1	1.3-43.3	62.0	9.78	1.96	02/07/86	2.05	62.5	1:1	02/07/86
												62.5	1:1	

				2	1	43.3-65.3	70.5	0.99	0.20	02/19/86				NOT REQ.
RR012SS	3+58.75	993.75	27	1	1	1.3-43.5	57.1	0.42	0.08	02/14/86				NOT REQ.
				2	1	43.5-65.7	65.6	0.87	0.17	02/20/86				NOT REQ.
RR012PP	3+63.75	993.50	27	1	1	1.3-11.9	50.0	9.6	1.92	02/07/86	4.13	50	1:1	02/07/86
												50.3	2:1	
				1	2	11.9-43.2	62.0	1.84	0.37	02/10/86	3.34			02/10/86
				2	1	43.2-65.6	70.6	0.52	0.10	02/19/86				NOT REQ.
RR011SS	3+68.75	993.50	27	1	1	1.3-43.2	57.0	1.42	0.28	02/14/86				NO RECOR
				2	1	43.2-65.6	65.6	1.65	0.33	02/20/86	0.60	36.4	4:1	02/21/86
												36.4	4:1	
RR011PP	3+73.75	993.50	27	1	1	1.3-13.5	46.5	0.31	0.06	01/15/86	0.50	46	3:1	01/16/86
												46	3:1	
				1	2	13.5-43.2	56.5	0.59	0.12	01/22/86	0.50	59.7	3:1	01/22/86
												59.7	3:1	
				2	1	43.2-66.7	71.1	0.53	0.11	02/04/86				NOT REQ.
RR010SS	3+78.75	993.50	27	1	1	1.3-43.2	57.0	1.27	0.25	01/31/86	1.05	56.7	3:1	01/31/86
												56.7	3:1	
				2	1	43.2-65.6	65.6	0.33	0.07	02/06/86				NOT REQ.
RR010PP	3+83.75	993.50	27	1	1	1.3-14.2	46.8	0.25	0.05	01/15/86	0.50	46	3:1	01/17/86
												46	3:1	
				1	2	14.2-43.1	59.7	1.73	0.35	01/22/86	0.35	59.7	3:1	01/22/86
												59.7	3:1	
				2	1	43.1-65.7	70.6	0.53	0.11	02/04/86				NOT REQ.
RR009SS	3+88.75	993.50	27	1	1	1.3-43.2	57.0	1.68	0.34	01/31/86	0.88	56.7	3:1	01/31/86
												56.7	3:1	
				2	1	43.2-65.6	65.6	0.53	0.11	02/06/86				NOT REQ.
RR009PP	3+93.75	993.50	27	1	1	1.3-13.9	46.7	0.00	0.00	01/15/85				NOT REQ.
				1	2	13.9-43.0	59.6	1.35	0.27	01/22/86	1.50	59.6	3:1	01/22/86
												59.6	3:1	
				2	1	43.0-65.6	70.6	0.30	0.06	02/04/86				NOT REQ.
RR008SS	3+98.75	993.50	27	1	1	1.3-43.2	57.0	2.90	0.58	01/31/86	0.46	56.7	3:1	01/31/86
												56.7	3:1	
				2	1	43.2-65.6	65.6	0.74	0.15	02/06/86				NOT REQ.
RR008PP	4+02.50	993.50	27	1	1	1.3-14.2	26.8	1.75	0.35	01/15/86	4.00	46	3:1	01/17/86
												46	3:1	

				1	2	14.2-30.0	53.8	2.1	0.42	01/22/86	1.00	53.8	3:1	01/22/86
												53.8	3:1	
				1	3	30.0-43.2	59.7	1.03	0.21	01/27/86	1.00			NO RECOR
				2	1	43.2-65.6	70.6	1.08	0.18	02/04/86				NOT REQ.
RR007SS	4+06.25	987.50	27	1	1	1.3-36.4	54.4	2.22	0.44	01/31/86	0.64	57.2	3:1	01/31/86
												57.2	3:1	
				2	1	36.4-58.9	63.0	0.19	0.04	02/06/86				NOT REQ.
RR007PP	4+13.75	993.50	27	1	1	1.3-16.2	47.7	0.00	0.00	01/15/86				NOT REQ.
				1	2	16.2-29.2	53.5	0.24	0.05	01/22/86		53.5	3:1	01/22/86
												53.5	3:1	
				1	3	28.0	53	1.38	0.27	01/27/86	0.84	53	3:1	01/27/86
												53	3:1	
				1	4	29.2-43.2	47.0	0.10	0.02	01/28/86				NOT REQ.
				2	1	43.2-65.6	70.6	0.33	0.07	02/04/86				NOT REQ.
RR006SS	4+18.75	993.50	27	1	1	1.3-31.4	52.0	0.52	0.10	01/30/86	0.80	56.7	3:1	01/31/86
												56.7	3:1	
				1	2	31.4-43.2	57.0	2.15	0.43	01/31/86				NO RECOR
				2	1	43.2-65.6	65.6	0.66	0.13	02/06/86				NOT REQ.
RR006PP	4+23.75	993.50	27	1	1	1.3-13.2	26.35	3.38	0.68	01/15/86	2.00	46	3:1	01/16/86
												46	3:1	
				1	2	13.2-43.8	60.0	1.21	0.24	01/22/86	0.60	60	3:1	01/22/86
												60	3:1	
				2	1	43.8-65.6	70.6	0.21	0.04	02/04/86				NOT REQ.
RR005SS	4+28.75	993.50	27	1	1	1.3-48.2	58.9	1.70	0.34	01/31/86	1.51	59.2	3:1	01/31/86
												59.2	3:1	
				2	1	48.2-65.6	65.6	0.12	0.02	02/06/86				NOT REQ.
RR005PP	4+33.75	993.50	27	1	1	1.3-13.2	36.35	12.45	2.49	01/15/86	3.00	46	2:1	01/17/86
												46	2:1	
				1	2	13.2-21.5	50.0	4.90	0.98	01/22/86	15.50	50	2:1	01/22/86
												50	3:1	
				1	3	21.5-34.9	56	2.02	0.40	01/27/86	0.81	56.0	3:1	01/27/86
												56.0	3:1	
				1	4	34.9-43.1	46.9	0.58	0.12	01/28/86				NOT REQ.
				2	1	43.1-65.6	70.6	0.77	0.15	02/04/86				NOT REQ.
LL001PP	4+38.75	993.75	27	1	1	1.3-43.5	61.6	0.48	0.10	03/27/86				NOT REQ.
				2	1	43.5-47.7	63.3	0.52	0.10	04/15/86				NOT REQ.

				2	2	47.7-65.9	70.2	0.65	0.13	04/17/86				NOT REQ.
RR004SS	4+38.75	993.75	27	1	1	1.3-43.5	57.1	1.96	0.39	01/30/86	0.37	56.9	3:1	01/31/86
												56.9	3:1	
				2	1	43.5-65.9	65.7	0.24	0.05	02/06/86				NOT REQ.
LL001SS	4+43.75	993.75	27	1	1	1.3-43.5	56.7	8.71	1.74	04/07/86	0.85	56.3	3:1	04/08/86
												56.3	3:1	
				2	1	43.5-65.9	65.2	2.68	0.54	04/22/86	0.78	70.5	4:1	04/22/86
												70.5	4:1	
RR004PP	4+43.75	993.75	27	1	1	1.3-13.2	26.35	2.94	0.59	01/15/86	5.00	45	3:1	01/16/86
												46	3:1	
				1	2	13.2-23.6	51.0	0.82	0.16	01/22/86	0.25	51	3:1	01/22/86
												51	3:1	
				1	3	23.6-43.5	59.9	0.75	0.15	01/27/86				NOT REQ.
				2	1	43.5-65.9	70.7	8.25	1.65	02/04/86	3.33	71.4	2:1	02/04/86
												71.4	2:1	
LL002PP	4+48.75	993.75	27	1	1	1.3-33.2	57.7	2.16	0.43	03/27/86	0.33	58.0	2:1	03/31/86
												58.0	2:1	
				1	2	33.2-43.5	61.7	0.66	0.13	04/03/86				NOT REQ.
				2	1	43.5-65.9	70.2	0.45	0.09	04/15/86				NOT REQ.
RR003SS	4+48.75	993.75	27	1	1	1.3-43.5	57.1	2.80	0.56	01/30/86	0.92	56.9	3:1	01/31/86
												56.9	3:1	
				2	1	43.5-65.9	65.7	0.21	0.04	02/06/86				NOT REQ.
LL002SS	4+53.75	993.75	27	1	1	1.3-47.5	58.2	8.85	1.77	04/07/86	0.08	58.3	3:1	04/08/86
												58.3	3:1	
				2	1	43.5-65.9	65.2	1.25	0.25	04/22/86	0.13	70.5	4:1	04/22/86
												70.5	4:1	
RR003PP	4+53.75	993.75	27	1	1	1.3-13.0	26.3	6.5	1.30	01/15/86	40.50	46	2:1	01/15/86
												46	3:1	
				1	2	13.0-18.2	48.5	12.4	2.48	01/22/86	5.40	48.5	2:1	01/22/86
												48.5	2:1	
				1	3	18.2-30.9	54.3	1.3	0.26	01/27/86	0.22	54.3	3:1	01/27/86
												54.3	3:1	
				1	4	30.9-43.5	47.1	0.35	0.07	01/28/86				NOT REQ
				2	1	43.5-65.9	70.7	7.30	1.46	02/04/86	0.11	71.4	2:1	02/04/86
												71.4	2:1	
GC003	4+56	993.70	0	0	0	0.0-62.5	0.00	0.00	0.00	05/16/86				NOT REQ.
LL003PP	4+58.75	993.75	27	1	1	1.3-15.5	50.9	4.72	0.94	03/27/86	0.33	39.9	1:1	03/27/86
												39.9	1:1	
				1	2	15.5-43.5	61.7	0.09	0.02	04/03/86				NOT REQ.

			2	1	43.5-65.9	70.2	0.27	0.05	04/15/86				NOT REQ.
RR002SS	4+58.75	993.75 27	1	1	1.3-40.8	56.1	2.1	0.42	01/30/86	0.62	56.1 56.1	3:1 3:1	01/31/86
			2	1	40.8-65.9	65.7	0.17	0.03	02/06/86				NOT REQ.
LL003SS	4+63.75	993.75 27	1	1	1.3-43.5	56.7	0.39	0.08	04/07/86				NOT REQ.
			2	1	43.5-65.9	65.2	0.45	0.09	04/22/86				NOT REQ.
RR002PP	4+63.75	993.75 27	1	1	1.3-14.8	47.1	1.3	0.26	01/15/86	3.00	4:1 47	3:1 4:1	01/16/86
			1	2	14.8-19.1	49.0	8.45	2.45	01/22/86	7.10	49 49	2:1 2:1	01/22/86
			1	3	19.1-43.5	59.9	0.87	0.17	01/27/86				NOT REQ.
			2	1	43.5-65.9	70.7	0.41	0.08	02/04/86				NOT REQ.
LL004PP	4+68.75	993.75 27	1	1	1.3-43.5	61.6	0.70	0.14	03/27/86				NOT REQ.
			2	1	43.5-65.9	70.2	0.30	0.06	04/15/86				NOT REQ.
RR001SS	4+68.75	993.75 27	1	1	1.3-43.5	57.1	5.0	1.00	01/30/86	1.58	56.9 56.9	3:1 3:1	01/31/86
			2	1	43.5-65.9	65.7	0.43	0.09	02/06/86				NOT REQ.
LL004SS	4+73.75	993.75 27	1	1	1.3-43.5	56.7	1.63	0.33	04/07/86	0.66	56.2 56.2	3:1 3:1	04/08/86
			2	1	43.5-65.9	65.2	1.15	0.23	04/22/86	1.00	70.5 70.5	4:1 4:1	04/22/86
RR001PP	4+73.75	993.75 27	1	2	11.7-18.1	48.5	6.19	1.20	01/22/86	1.50	48.5 48.5	2:1 2:1	01/22/86
			1	3	18.1-43.5	59.9	1.3	0.26	01/27/86	0.56	59.9 59.9	3:1 3:1	01/27/86
			2	1	43.5-65.9	70.7	0.20	0.04	02/04/86				NOT REQ.
LL005PP	4+78.75	993.75 27	1	1	1.3-20.5	52.9	3.97	0.79	03/27/86	2.91	52.1 52.1	2:1 2:1	03/31/86
			1	2	20.5-43.5	61.7	1.60	0.32	04/03/86	1.00	61.3 61.3	3:1 3:1	04/03/86
			2	1	43.5-65.9	70.2	0.52	0.10	04/15/86				NOT REQ.
LL005T1	4+81.25	994.00 27	1	1	1.3-15.7	46.0	0.07	0.01	04/24/86				NOT REQ.
			1	2	15.7-33.9	53.0	2.05	0.41	05/01/86	1.50			05/02/86
			1	3	33.9-38.2	54.6	0.86	0.17	05/05/86				NOT REQ.

LL005SS	4+83.75	994.00	27	1	1	1.3-43.5	56.7	1.37	0.27	04/07/86	0.43	56.2	3:1	04/08/86
												56.2	3:1	
				2	1	43.5-65.9	65.2	0.12	0.02	04/22/86				NOT REQ.
LL005T2	4+86.25	994.00	27	1	1	1.3-15.7	46.0	0.02	0.01	04/24/86				NOT REQ.
				1	2	15.7-38.2	54.6	0.43	0.09	05/01/86				NOT REQ.
LL006PP	4+88.75	994.00	27	1	1	1.3-19.5	52.5	11.56	2.31	03/27/86	12.28	52.9	2:1	03/31/86
												52.9	2:1	
				1	2	19.5-43.5	61.7	0.42	0.08	04/03/86				NOT REQ.
				2	1	43.5-65.9	70.2	1.53	0.31	04/15/86	0.68	70.3	3:1	04/15/86
												70.3	3:1	
LL006T1	4+91.25	994.00	27	1	1	1.3-15.7	46.0	0.13	0.03	04/24/86				NOT REQ.
				1	2	15.7-38.2	54.6	0.44	0.09	05/01/86				NOT REQ.
LL006SS	4+93.75	994.00	27	1	1	1.3-43.5	56.7	0.08	0.02	04/07/86				NOT REQ.
				2	1	43.5-65.9	65.2	0.27	0.05	04/22/86				NOT REQ.
LL006T2	4+96.25	994.00	27	1	1	1.3-15.7	46.0	0.38	0.08	04/24/86				NOT REQ.
				1	2	15.7-38.2	54.6	0.81	0.16	05/01/86				NOT REQ.
LL007PP	4+98.75	994.00	27	1	1	1.3-17.0	51.5	8.30	2.30	03/27/86	15.23	51.2	2:1	03/31/86
												51.2	2:1	
				1	2	17.0-43.5	61.7	0.12	0.02	04/03/86				NOT REQ.
				2	1	43.5-65.9	70.2	0.45	0.09	04/15/86				NOT REQ.
LL007T1	5+01.25	994.00	27	1	1	1.3-15.1	45.8	0.05	0.01	04/25/86				NOT REQ.
				1	2	15.1-38.2	54.6	0.20	0.04	05/01/86				NOT REQ.
LL007SS	5+03.75	994.00	27	1	1	1.3-43.5	56.7	0.03	0.01	04/07/86				NOT REQ.
				2	1	43.5-65.9	65.2	0.52	0.10	04/22/86				NOT REQ.
LL007T2	5+06.25	995.00	27	1	1	1.3-16.3	46.2	0.21	0.04	04/25/86				NOT REQ.
				1	2	16.3-39.3	55.0	0.27	0.05	05/01/86				NOT REQ.
LL008PP	5+08.75	997.00	27	1	1	1.3-19.9	52.6	9.31	2.33	03/27/86	0.15	52.8	2:1	03/31/86
												52.8	2:1	

				1	2	19.9-43.5	61.7	0.07	0.01	04/03/86				NOT REQ.
				2	1	43.5-65.5	70.1	0.11	0.02	04/15/86				NOT REQ.
LL008T1	5+11.25	998.75	27	1	1	1.3-20.0	4737	0.37	0.07	04/25/86				NOT REQ.
				1	2	20.0-43.5	56.7	0.49	0.10	05/01/86				NOT REQ.
LL008SS	5+13.75	1000.50	27	1	1	1.3-51.1	59.6	0.30	0.06	04/07/86				NOT REQ.
				2	1	51.1-73.5	68.2	1.37	0.27	04/22/86		74.0	4:1	04/22/86
												74.0	4:1	
LL008T2	5+16.25	1002.50	27	1	1	1.3-21.8	48.3	0.34	0.07	04/25/86	0.34	40	3:1	04/25/86
												40	3:1	
				1	2	21.8-47.7	58.3	0.12	0.02	05/01/86				NOT REQ.
LL009PP	5+18.75	1003.50	27	1	1	1.3-54.4	65.8	1.04	0.21	03/27/86	3.65	65.6	2:1	03/31/86
												65.7	4:1	
				2	1	54.4-76.9	74.5	0.06	0.01	04/15/86				NOT REQ.
LL009T1	5+21.25	1003.50	27	1	1	1.3-26.0	50.0	2.15	0.43	04/25/86	0.70			04/25/86
				1	2	26.0-48.8	58.7	0.30	0.06	05/01/86				NOT REQ.
LL009SS	5+23.75	1003.50	27	1	1	1.3-54.4	60.8	0.21	0.04	04/07/86				NOT REQ.
				2	1	54.4-76.9	69.5	0.30	0.06	04/22/86				NOT REQ.
LL009T2	5+26.25	1003.50	27	1	1	1.3-27.2	50.4	0.03	0.01	04/25/86				NOT REQ.
				1	2	27.2-48.8	58.7	0.06	0.01	05/01/86				NOT REQ.
LL010PP	5+28.75	1004.00	27	1	1	1.3-55.0	65.8	1.05	0.21	03/27/86	0.22	65.7	3:1	03/15/86
												65.7	3:1	
				2	1	55.0-77.4	74.7	0.12	0.02	04/15/86				NOT REQ.
LL010T1	5+31.25	1004.00	27	1	1	1.3-27.5	50.5	0.03	0.01	04/25/86				NOT REQ.
				1	2	27.5-49.4	58.9	0.10	0.02	05/01/86				NOT REQ.
LL010SS	5+33.75	1004.00	27	1	1	1.3-55.0	61.1	0.35	0.07	04/07/86				NOT REQ.
				2	1	55.0-77.4	69.7	0.28	0.06	04/22/86				NOT REQ.
LL010T2	5+36.25	1004.00	27	1	1	1.3-27.1	50.4	0.53	0.11	04/25/86				NOT REQ.

				1	2	27.1-55.0	61.1	0.72	0.14	05/01/86	0.28			05/02/86
LL011PP	5+38.75	1004.00	27	1	1	1.3-55.0	66.1	9.47	1.90	03/27/86	17.30	66.3	1:1	03/27/86
												66.9	3:1	
				2	1	55.0-77.4	74.6	2.25	0.45	04/15/86	1.00	74.9	3:1	04/15/86
												74.9	3:1	
LL011Q1	5+40	1004.00	27	1	1	1.3-55.0	61.1	0.95	0.19	05/07/86				NOT REQ.
LL011T1	5+41.25	1004.00	27	1	1	1.3-25.6	49.8	0.80	0.16	04/25/86				NOT REQ.
				1	2	26.9-55.0	61.1	2.54	0.51	05/01/86	4.35			05/02/86
LL011Q2	5+42.50	1004.00	27	1	1	1.3-55.0	61.1	0.82	0.16	05/07/86				NOT REQ.
LL011SS	5+43.75	1004.00	27	1	1	1.3-55.0	61.1	3.94	0.79	04/07/86	8.44	61.0	2:1	04/07/86
												61.1	3:1	
				2	1	55.0-77.4	69.7	0.30	0.06	04/22/86				NOT REQ.
LL011T2	5+46.25	1004.00	27	1	1	1.3-26.1	50.0	0.23	0.05	04/25/86				NOT REQ.
				1	2	27.4-58.0	62.2	1.81	0.36	05/01/86	0.90			05/02/86
LL012PP	5+48.75	1004.00	27	1	1	1.3-21.2	28.6	9.45	1.89	02/27/86	6.98	53.5	2:1	02/28/86
												53.5	2:1	
				1	2	26.8-34.3	38.1	9.05	1.81	03/05/86	21.88	28.7	1:1	03/05/86
												59.0	2:1	
				1	3	34.3-55.0	66.5	2.93	0.59	03/07/86	3.71	66.4	2:1	03/07/86
												66.4	2:1	
				2	1	55.0-77.4	75.1	0.63	0.15	03/19/86				NOT REQ.
LL012SS	5+53.75	1004.25	27	1	1	1.3-34.1	53.1	1.68	0.34	03/12/86	1.20	4:1 5	0.01	03/12/86
												53.8	4:1	
				1	2	34.1-55.3	61.2	1.87	0.37	03/14/86	1.09	61.1	3:1	03/14/86
												61.1	3:1	
				2	1	55.3-77.7	69.8	0.32	0.06	03/25/86				NOT REQ.
LL013PP	5+58.75	1004.25	27	1	1	1.3-26.2	32.4	9.55	1.91	02/27/86	1.74	55.5	2:1	02/28/86
												55.5	2:1	
				1	2	26.2-33.1	39.7	9.00	1.80	03/05/86	14.01	58.0	2:1	03/05/86
												58.0	2:1	
				1	3	33.1-40.1	60.8	2.85	0.57	03/07/86	0.55	61.1	2:1	03/07/86
												61.1	2:1	
				1	4	40.1-55.3	66.2	1.41	0.28	03/10/86	0.95	66.1	3:1	03/10/86
												66.1	3:1	
				2	1	55.3-76.0	74.5	0.40	0.08	03/19/86				NOT REQ.
LL013Q1	5+60	1004.20	27	1	1	1.3-55.0	61.1	1.88	0.37	05/07/86	0.92	69.9	0.07	05/07/86
												69.9	2:1	

LL013T1	5+61.25	1004.25	27	1	1	1.3-28.2	50.8	5.99	1.20	04/25/86	7.30			04/25/86
				1	2	28.2-40.0	55.3	1.31	0.26	05/02/86	6.05	59.6	3:1	05/02/86
												59.6	3:1	
				1	3	40.0-55.0	61.1	0.50	0.10	05/05/86				NOT REQ.
LL013Q2	5+62.25	1004.20	27	1	1	1.3-55.0	61.1	3.87	0.77	05/07/86	2.33	69.9	2:1	05/07/86
												69.9	2:1	
LL013SS	5+63.75	1004.25	27	1	1	1.3-36.4	53.9	1.32	0.26	03/12/86	1.18	53.8	4:1	03/12/86
												53.8	4:1	
				1	2	36.4-54.6	60.9	6.98	1.40	03/14/86	5.36	60.7	2:1	03/14/86
												61.1	3:1	
				2	1	54.6-74.4	68.5	0.51	0.10	03/25/86				NOT REQ.
LL013T2	5+66.25	1004.50	27	1	1	1.3-29.4	51.3	0.11	0.02	04/25/86				NOT REQ.
				1	2	29.4-39.1	55.0	1.95	0.39	05/02/86		59.6	3:1	05/02/86
												59.6	3:1	
				1	3	39.1-54.8	61.0	0.67	0.13	05/05/86				NOT REQ.
LL014PP	5+68.75	1006.50	27	1	1	1.3-54.9	66.5	5.55	1.11	02/27/86	69.68	66.8	1:1	02/28/86
												67.2	2:1	
				2	1	54.9-74.6	74.0	0.59	0.12	03/19/86				NOT REQ.
GC004	5+70	1007.50	0	0	0	0.0-77.1	0.00	0.00	0.00	05/15/86	4.00	74.4	3:1	05/16/86
												74.4	3:1	
LL014T1	5+71.25	1008.25	27	1	1	1.3-27.6	45.6	0.49	0.10	04/25/86				NOT REQ.
				1	2	27.6-55.8	61.4	0.24	0.05	05/02/86				05/02/86
LL014SS	5+73.75	1010.00	27	1	1	1.3-56.6	56.7	9.50	1.90	03/12/86	11.26	56.3	1:1	03/12/86
												56.3	1:1	
				2	1	56.6-76.3	0.00	0.00	0.00	03/25/86	0.10	64.0	1:1	03/25/86
												64.0	1:1	
LL014T2	5+76.25	1011.75	27	1	1	1.3-57.6	57.1	1.37	0.27	04/30/86	2.23	65.0	4:1	04/30/86
												65.0	4:1	
LL015PP	5+78.75	1013.75	27	1	1	1.3-58.5	62.8	3.35	0.67	02/27/86	5.60	62.8	2:1	02/28/86
												62.8	2:1	
				2	1	58.5-78.3	70.4	5.50	1.10	03/19/86	14.00	70.6	2:1	03/19/86
												70.6	2:1	
LD001PP	5+81	1015.00	15	1	1	1.3-31.0	0.00	0.00	0.00					NOT REQ.
LD002PP	5+81	1015.00	10	1	1	1.3-30.5	42.9	0.25	0.05	04/08/86				NOT REQ.

VV013PP	5+81	1014.00	0	1	1	1.3-34.0	49.6	0.18	0.04	03/25/86				NOT REQ.
LL015T1	5+81.25	1014.00	27	1	1	1.3-57.6	57.1	0.55	0.11	04/30/86				NOT REQ.
LL015SS	5+83.75	1014.00	27	1	1	1.3-56.6	56.7	0.17	0.03	03/12/86	0.19	56.3	1:1	03/12/86
												56.3	1:1	
				2	1	56.6-77.3	0.00	0.00	0.00	03/25/86	1.00	64.6	1:1	03/25/86
												64.6	1:1	
LL015T2	5+86.25	1014.00	27	1	1	1.3-56.1	56.5	1.94	0.39	04/30/86		62.5	3:1	04/30/86
												62.5	3:1	
LL016PP	5+88.75	1014.50	27	1	1	1.3-55.6	59.7	8.95	1.79	02/27/86	8.15	61.6	0.31	02/28/86
												62.2	2:1	
				2	1	55.6-75.1	69.2	2.67	0.53	03/19/86	10.50	69.2	1:1	03/19/86
												69.8	3:1	
LL016Q1	5+90	1015.50	27	1	1	1.3-56.0	56.4	0.31	0.06	05/05/86				NOT REQ.
LL016T1	5+91.25	1016.50	27	1	1	1.3-56.7	56.7	8.28	1.65	04/30/86	10.72	62.7	2:1	04/30/86
												65.3	3:1	
LL016Q2	5+92.50	1017.50	27	1	1	1.3-57.2	56.9	0.05	0.01	05/05/86				NOT REQ.
LL016SS	5+93.75	1018.50	27	1	1	1.3-57.7	57.1	9.94	2.02	03/12/86	27.83	57.0	1:1	03/12/86
												57.4	2:1	
				2	1	57.7-77.2	64.6	0.23	0.05	03/25/86				NOT REQ.
LL016T2	5+96.25	1020.25	27	1	1	1.3-58.6	57.4	3.33	0.67	04/30/86	0.23	63.7	3:1	04/30/86
												63.7	3:1	
LL017PP	5+98.75	1022.25	27	1	1	1.3-56.1	42.9	9.20	1.84	02/27/86	14.08	57.5	2:1	02/28/86
												57.5	2:1	
				1	2	56.1-59.5	58.18	0.14	0.03	03/05/86				NOT REQ.
				2	1	59.5-78.0	65.3	0.64	0.13	03/19/86				NOT REQ.
LL017T1	6+01.25	1024.00	27	1	1	1.3-59.0	52.6	0.05	0.01	04/30/86				NOT REQ.
LL017SS	6+03.75	1024.00	27	1	1	1.3-58.5	52.4	0.57	0.11	03/12/86				NOT REQ.
				2	1	58.5-76.5	59.3	0.37	0.07	03/25/86				NOT REQ.
LL017T2	6+06.25	1024.50	27	1	1	1.3-58.1	52.3	0.65	0.13	04/30/86				NOT REQ.
LL018PP	6+08.75	1026.25	27	1	1	1.3-57.7	42.5	9.15	1.83	02/27/86	10.92	57.4	2:1	03/03/86
												57.4	2:1	
				2	1	57.7-75.8	64.5	0.06	0.01	03/19/86				NOT REQ.

LL018T1	6+11.25	1028.25	27	1	1	1.3-57.7	52.1	0.50	0.10	04/30/86				NOT REQ.
LL018SS	6+13.75	1029.75	27	1	1	1.3-57.6	52.1	5.75	1.15	03/12/86	18.41	52.2	2:1	03/12/86
												52.7	4:1	
				2	1	57.6-75.9	59.1	6.14	1.23	03/25/86	3.97	59.2	1:1	03/25/86
												59.6	2:1	
LL018T2	6+16.25	1031.75	27	1	1	1.3-58.0	52.2	0.76	0.15	04/30/86				NOT REQ.
GC005	6+17	1032.50	0	0	0	0.0-87.8	0.00	0.00	0.00	05/15/86	13.60	71.6	1:1	05/16/86
												82.3	3:1	
LL019PP	6+18.75	1033.75	27	1	1	1.3-58.3	52.7	7.40	1.48	02/27/86	8.13	52.7	2:1	03/03/86
												52.7	2:1	
				2	1	58.3-76.4	59.7	0.27	0.05	03/19/86				NOT REQ.
VV014PP	6+21	1034.00	0	1	1	1.3-39.0	41.8	0.31	0.06	03/25/86				NOT REQ.
LL019T1	6+21.25	1033.75	27	1	1	1.3-56.6	46.7	0.94	0.19	04/30/86	0.73	57.7	3:1	04/30/86
												57.7	3:1	
LD003PP	6+22.25	1035.00	10	1	1	1.3-35.5	40.0	1.41	0.28	04/17/86	0.80	39.9	4:1	04/17/86
												39.9	4:1	
LL019SS	6+23.75	1033.75	27	1	1	1.3-54.9	46.0	1.19	0.24	03/12/86	1.89	46.0	4:1	03/12/86
												46.0	4:1	
				2	1	54.9-73.0	53.0	0.22	0.04	03/25/86				NOT REQ.
LL019T2	6+26.25	1034.00	27	1	1	1.3-53.6	45.5	0.28	0.06	04/30/86				NOT REQ.
LL020PP	6+28.75	1034.00	27	1	1	1.3-46.1	36.1	9.25	1.85	02/27/86	26.38	48.6	1:1	02/28/86
												48.6	1:1	
				1	2	47.4-52.8	50.61	0.31	0.06	03/05/86				NOT REQ.
				2	1	52.8-70.4	57.4	0.29	0.06	03/19/86				NOT REQ.
LL020T1	6+31.25	1034.00	27	1	1	1.3-50.9	44.5	0.54	0.11	04/30/86				NOT REQ.
LL020SS	6+33.75	1034.00	27	1	1	1.3-49.4	43.9	1.16	0.23	03/12/86	0.84	43.9	4:1	03/12/86
												43.9	4:1	
				2	1	49.4-67.5	50.9	1.20	0.24	03/25/86	3.54	51.0	2:1	03/25/86
												51.6	4:1	
LL020T2	6+36.25	1035.25	27	1	1	1.3-49.4	43.9	0.91	0.18	04/30/86				NOT REQ.
LL021PP	6+38.75	1037.50	27	1	1	1.3-49.4	35.4	9.15	1.83	02/27/86	38.54	49.7	1:1	03/03/86
												49.8	2:1	

				2	1	49.4-67.8	56.4	5.55	1.11	03/19/86	27.60	56.5	1:1	03/20/86
												56.8	2:1	
LL021SS	6+43.75	1039.00	27	1	1	1.3-47.8	38.3	1.15	0.23	04/11/86	2.00	38.4	3:1	04/14/86
												38.7	4:1	
				2	1	47.8-67.6	45.9	0.91	0.18	04/23/86				NOT REQ.
LL022PP	6+48.75	1041.75	27	1	1	1.3-48.5	43.6	2.26	0.45	04/02/86	4.60	43.8	3:1	04/02/86
												43.8	3:1	
				2	1	48.5-68.5	46.2	7.5	1.50	04/17/86	0.31	53.9	1:1	04/17/86
												53.9	1:1	
LL022SS	6+53.75	1045.00	27	1	1	1.3-50.1	39.2	0.10	0.02	04/11/86				NOT REQ.
				2	1	50.1-70.1	46.9	0.72	0.14	04/23/86				NOT REQ.
LL022T2	6+56.25	1046.75	27	1	1	1.3-27.8	30.6	0.25	0.05	04/30/86				NOT REQ.
LL023PP	6+58.75	1048.50	27	1	1	1.3-15.4	16.9	6.45	1.29	04/02/86	53.75	25.9	1:1	04/02/86
												26.4	2:1	
				1	2	15.9-52.1	40.0	4.87	0.97	04/07/86	7.56	40.3	2:1	04/08/86
												40.5	3:1	
				2	1	52.1-72.2	42.7	2.12	0.42	04/17/86	31.42	49.2	1:1	04/17/86
												49.2	2:1	
VV015PP	6+61	1048.75	0	1	1	1.3-26.8	26.5	0.04	0.01	04/23/86				NOT REQ.
LL023T1	6+61.25	1048.80	27	1	1	1.3-71.5	42.4	1.50	0.30	04/30/86	0.88	50.0	3:1	04/30/86
												50.0	3:1	
LL023SS	6+63.75	1048.75	27	1	1	1.3-50.8	34.5	0.85	0.17	04/11/86				NOT REQ.
				2	1	50.8-70.9	42.2	5.58	1.12	04/23/86	15.00	49.7	2:1	04/23/86
												53.5	3:1	
LL023T2	6+66.25	1048.75	27	1	1	1.3-70.0	41.8	4.88	0.98	04/30/86	1.86	49.3	3:1	04/30/86
												49.3	3:1	
LL024PP	6+68.75	1049.00	27	1	1	1.3-49.4	38.9	2.67	0.53	04/02/86	8.05	38.8	2:1	04/02/86
												39.2	3:1	
				2	1	49.4-69.4	41.6	10.06	2.01	04/17/86	72.00	54.5	1:1	04/17/86
												54.5	2:1	
LL024SS	6+73.75	1049.00	27	1	1	1.3-47.8	33.3	1.53	0.30	04/11/86	0.90	33.4	3:1	04/14/86
												33.4	3:1	
				2	1	47.8-67.8	41.0	0.25	0.05	04/23/86				NOT REQ.
LL025PP	6+78.75	1052.00	27	1	1	1.3-49.0	38.8	5.50	1.10	04/02/86	7.20	34.0	3:1	04/02/86
												34.0	3:1	
				2	1	49.0-69.0	41.4	1.06	0.21	04/17/86	17.30	41.4	1:1	04/17/86
												54.3	4:1	

LL025T1	6+81.25	1053.25	27	1	1	1.3-49.9	34.1	3.31	0.66	04/30/86	0.31	39.5	3:1	04/30/86
												39.5	3:1	
LL025SS	6+83.75	1055.50	27	1	1	1.3-50.8	34.5	6.20	1.24	04/11/86	7.00	34.6	1:1	04/14/86
												34.6	1:1	
				2	1	50.8-69.9	41.8	0.46	0.09	04/23/86				NOT REQ.
LL025T2	6+86.25	1057.25	27	1	1	1.3-51.3	34.7	1.10	0.22	04/30/86	0.98	40.1	3:1	04/30/86
												40.1	3:1	
LL026PP	6+88.75	1059.00	27	1	1	1.3-51.8	35.9	1.34	0.27	04/02/86	0.33	35.4	3:1	04/02/86
												35.4	3:1	
				2	1	51.8-70.9	42.2	9.1	1.82	04/17/86	31.18	48.5	1:1	04/17/86
												55.4	2:1	
LL026SS	6+93.75	1060.00	27	1	1	1.3-50.5	34.3	2.73	0.55	04/11/86	4.65	34.4	2:1	04/11/86
												34.7	3:1	
				2	1	50.5-69.4	41.6	1.60	0.32	04/23/86	0.80	48.9	3:1	04/23/86
												48.9	3:1	
LL026T2	6+96.25	1061.75	27	1	1	1.3-26.8	25.3	0.45	0.09	04/30/86				NOT REQ.
LL027PP	6+98.75	1063.50	27	1	1	1.3-51.4	32.7	6.27	1.25	04/02/86	5.21	35.2	3:1	04/02/86
												35.2	3:1	
				2	1	51.4-61.0	33.4	8.65	1.73	04/17/86	9.28	49.2	1:1	04/17/86
												49.2	1:1	
				2	2	51.4-70.5	42.0	0.73	0.15	04/21/86				NOT REQ.
VV016PP	7+01	1063.50	0	1	1	1.3-28.5	22.3	0.20	0.04	04/23/86				NOT REQ.
LL027SS	7+03.75	1063.50	27	1	1	1.3-49.0	28.8	0.90	0.18	04/11/86				NOT REQ.
				2	1	49.0-68.1	36.1	0.79	0.16	04/23/86				NOT REQ.
LL028PP	7+08.75	1063.50	27	1	1	1.3-46.6	32.9	5.35	1.07	04/02/86	10.53	32.8	3:1	04/02/86
												32.8	3:1	
				2	1	46.6-59.0	32.6	10.18	2.03	04/17/86	33.58	47.9	1:1	04/18/86
												47.9	1:1	
				2	2	59.0-65.5	40.1	0.35	0.07	04/21/86				NOT REQ.
LL028SS	7+13.75	1063.50	27	1	1	1.3-44.3	27.0	1.52	0.30	04/11/86	0.37	27.1	2:1	04/14/86
												27.1	2:1	
				2	1	44.3-63.3	34.3	2.22	0.44	04/23/86	1.14	44.4	2:1	04/23/86
												44.4	3:1	
LL029PP	7+18.75	1064.00	27	1	1	1.3-42.3	31.2	0.39	0.08	04/02/86				NOT REQ.
				2	1	42.3-61.3	33.5	9.47	1.89	04/17/86	118.41	43.3	1:1	04/18/86
												43.3	**	
LL029SS	7+23.75	1064.00	27	1	1	1.3-40.0	25.3	0.90	0.18	04/11/86				NOT REQ.

				2	1	40.0-60.4	33.1	0.33	0.07	04/23/86				NOT REQ.
LL030PP	7+28.75	1064.00	27	1	1	1.3-38.2	29.6	1.73	0.35	04/02/86	1.78	29.7	3:1	04/02/86
												29.7	3:1	
				2	1	38.2-60.1	33.0	5.43	1.09	04/17/86	18.47	48.5	1:1	04/18/86
												48.5	1:1	
LF001SS	7+32.56	1065.00	34.31	1	1	2.4-39.8	24.8	5.85	1.17	04/08/86	5.18	25.0	2:1	04/08/86
												25.0	3:1	
				2	1	39.8-61.2	31.7	0.50	0.10	04/22/86				NOT REQ.
LF001PP	7+32.73	1064.00	30.61	1	1	1.3-14.0	42.9	4.82	0.96	04/08/86	10.30	13.3	1:1	03/17/86
												13.6	3:1	
				1	2	14.0-37.2	23.7	0.20	0.04	03/26/86				NOT REQ.
				2	1	37.2-58.8	32.9	10.90	2.18	04/17/86	22.18	39.5	1:1	04/18/86
												42.4	2:1	
LF002PP	7+32.89	1065.00	38.28	1	1	2.4-13.3	12.5	4.04	0.81	03/13/86	0.40	12.3	2:1	03/17/86
												12.3	2:1	
				1	2	13.3-38.8	23.1	0.87	0.17	03/26/86				NOT REQ.
				2	1	38.8-60.1	30.3	0.24	0.05	04/17/86				NOT REQ.
LF002SS	7+33.27	1065.00	42.45	1	1	2.4-38.8	22.8	2.40	1.20	04/08/86	0.72	23.3	3:1	04/08/86
												23.3	3:1	
				2	1	38.8-60.1	29.1	1.28	0.26	04/22/86	0.72			NO RECOR
LF003PP	7+33.70	1065.00	46.78	1	1	1.3-25.0	23.5	3.05	0.61	03/18/86	0.55	12.7	2:1	03/17/86
												12.7	2:1	
				1	2	16.1-38.8	21.4	0.15	0.03	03/26/86				NOT REQ.
				2	1	38.8-60.1	[illegible]	0.51	0.10	04/17/86				NOT REQ.
LL030SS	7+33.75	1064.00	27	1	1	1.3-37.6	24.4	0.65	0.13	04/11/86				NOT REQ.
				2	1	37.6-58.6	32.4	[illegible]	0.07	04/23/86				NOT REQ.
LF003SS	7+34.22	1065.00	51.25	1	1	2.4-38.8	20.7	0.89	0.18	04/08/86	0.10	20.7	3:1	04/08/86
												20.7	3:1	
				2	1	38.8-60.1	26.2	0.09	0.02	04/22/86				NOT REQ.
LF004PP	7+35	1064.90	55.84	1	1	1.3-14.8	11.6	0.07	0.01	03/13/86				NOT REQ.
				1	2	14.8-39.4	19.5	5.25	1.05	03/26/86	9.85	19.2	2:1	03/27/86
												19.5	3:1	
				2	1	39.4-60.6	24.6	0.02	0.00	04/17/86				NOT REQ.
LF004SS	7+35	1065.39	60.53	1	1	1.3-38.3	18.2	2.52	1.26	04/08/86	0.71	18.6	3:1	04/08/86
												18.6	3:1	

				2	1	39.4-60.6	22.8	2.93	0.59	04/22/86	0.71			NO RECOR
LF005PP	7+35	1065.83	65.31	1	1	1.3-15.2	10.7	0.29	0.06	03/13/86				NOT REQ.
				1	2	15.2-38.8	17.0	3.4	0.68	03/26/86	1.17	17.0	2:1	03/27/86
												17.0	2:1	
				2	1	38.8-60.1	20.9	0.16	0.03	04/17/86				NOT REQ.
LF005SS	7+35	1066.24	70.16	1	1	1.3-39.4	15.8	0.18	0.04	04/08/86	0.09	15.4	3:1	04/08/86
												15.4	3:1	
				2	1	38.3-59.6	18.7	0.08	0.02	04/22/86				NOT REQ.
LF006PP	7+35	1066.63	75.07	1	1	1.3-15.3	9.7	0.72	0.14	03/13/86				NOT REQ.
				1	2	15.3-38.0	14.2	2.18	0.44	03/26/86	1.66	14.0	2:1	03/27/86
												14.0	2:1	
				2	1	38.0-59.4	16.6	0.77	0.15	04/17/86				NOT REQ.
LF006SS	7+35	1066.99	80.02	1	1	1.3-38.3	12.9	2.88	0.58	04/08/86	2.98	12.7	3:1	04/09/86
												12.7	3:1	
				2	1	38.3-59.1	14.4	0.37	0.07	04/22/86				NOT REQ.
LF007PP	7+35	1067.35	85.0	1	1	1.3-15.1	8.6	0.15	0.03	03/13/86				NOT REQ.
				1	2	15.1-38.3	11.4	0.30	0.06	03/26/86				NOT REQ.
				2	1	38.3-59.1	12.2	0.14	0.03	04/17/86				NOT REQ.
LF007SS	7+35	1067.70	90.0	1	1	1.3-38.6	10.0	0.60	0.12	04/08/86				NOT REQ.
				2	1	38.6-59.9	10.0	1.87	0.37	04/22/86	1.43	10.0	3:1	04/23/86
												10.0	3:1	
LF008PP	7+35	1068.05	95.0	1	1	1.3-15.4	7.4	0.40	0.08	03/13/86	0.51	7.3	3:1	03/17/86
												7.3	3:1	
				1	2	15.4-39.3	8.6	1.95	0.39	03/26/86	2.14	8.1	3:1	03/27/86
												8.1	3:1	
				2	1	39.3-61.2	7.7	4.01	0.80	04/17/86	7.07	6.8	2:1	04/18/86
												6.8	2:1	
LF008SS	7+35	1068.41	99.98	1	1	1.3-40.4	7.0	2.50	0.50	04/08/86	3.63	7.2	3:1	04/09/86
												7.2	3:1	
				2	1	40.4-62.8	5.3	0.30	0.05	04/22/86				NOT REQ.
LF009PP	7+35	1068.77	104.9	1	1	1.3-16.4	6.2	1.68	0.34	03/13/86	3.43	6.7	3:1	03/17/86
												6.7	3:1	
				1	2	16.4-42.3	5.3	0.28	0.06	03/26/86				NOT REQ.
				2	1	42.3-65.4	0.8	0.00	0.00	04/17/86				NOT REQ.

LS001PP	7+40.9	1102.00	20	1	1	18.8-37.2	20.0	4.66	0.93	05/22/86	0.51			05/23/86
LS001SS	7+43.3	1102.00	20	1	1	21.3-37.2	20.0	0.90	0.18	05/28/86				NOT REQ.
LS002PP	7+45.6	1102.10	20	1	1	21.4-37.3	20.1	0.61	0.12	05/22/86				NOT REQ.
LS002SS	7+48.0	1102.10	20	1	1	21.4-37.3	20.1	8.00	1.60	05/28/86				05/29/86
LS009SS	7+49.9	1102.00	15	1	1	18.6-27.9	16.6	0.00	0.00	05/28/86				NOT REQ.
LS003PP	7+50.3	1102.00	20	1	1	21.3-37.2	20.0	0.16	0.03	05/22/86				NOT REQ.
GC008	7+51.5	1102.00	0	0	0	24.7-92.5	0.00	0.00	0.00	06/02/86				NOT REQ.
LS003SS	7+52.7	1101.90	20	1	1	21.2-37.1	20.0	0.00	0.00	05/28/86				NOT REQ.
LS010PP	7+53.4	1101.80	20	1	1	18.9-37.0	20.0	5.52	1.10	05/22/86	10.88	22.7	1:1	05/23/86
												30.0	4:1	
LS004PP	7+55.0	1101.80	20	1	1	21.1-37.0	20.0	6.02	1.20	05/22/86	23.27	30.0	1:1	05/23/86
												30.0	1:1	
LS010SS	7+55.8	1101.70	20	1	1	19.9-49.7	25.1	0.66	0.13	05/28/86				NOT REQ.
LS004SS	7+57.4	1101.60	20	1	1	20.8-36.7	19.8	0.00	0.00	05/28/86				NOT REQ.
LS011PP	7+58.3	1101.50	20	1	1	20.7-49.4	25.0	1.45	0.29	05/22/86	0.12	29.1	4:1	05/23/86
												29.1	4:1	
LS005PP	7+59.7	1101.30	20	1	1	20.5-36.4	19.7	0.00	0.00	05/22/86				NOT REQ.
LS011SS	7+60.5	1101.00	20	1	1	20.2-48.9	24.7	0.60	0.12	05/28/86	1.07	38.0	1:1	05/29/86
												38.0	1:1	
LS005SS	7+62.1	1101.90	20	1	1	21.2-37.1	2.0	1.42	0.28	05/28/86	2.86	24.2	2:1	05/29/86
												26.3	3:1	
LS006PP	7+64.4	1100.90	20	1	1	20.1-36.0	19.5	6.07	1.21	05/22/86	13.08	25.6	1:1	05/23/86
												25.6	2:1	
LS006SS	7+66.8	1100.80	20	1	1	20.0-35.9	19.5	0.47	0.09	05/28/86				NOT REQ.
LS007PP	7+69.1	1100.80	20	1	1	20.0-35.9	19.5	0.00	0.00	05/22/86				NOT REQ.

LS007SS	7+71.5	1100.60	20	1	1	19.8-35.7	19.4	0.63	0.13	05/28/86				NOT REQ.
LS008PP	7+73.8	1100.70	20	1	1	19.9-35.8	19.5	2.07	0.41	05/22/86	1.00	25.5	2:1	05/23/86
												25.5	2:1	
LS008SS	7+76.2	1100.70	20	1	1	19.9-35.8	19.5	0.40	0.08	05/28/86				NOT REQ.
LS009PP	7+78.5	1100.60	20	1	1	19.8-35.7	19.4	0.66	0.13	05/22/86				NOT REQ.

04/21/87

PRESSURE FLOW AND GROUT TAKE FOR HOLE AND DEPTH RANGE SHOWN

HOLE RANGE: LD001PP - VV016PP
DEPTH RANGE: 0.0- **.*

HOLE NO.	INTERVAL, FT	WATER CFM	TAKE, SKS	DATE PT	DATE GR
LD001PP	1.3-31.0	0.00	0.00		NOT REQ.
LD002PP	1.3-30.5	0.05	0.00	04/08/86	NOT REQ.
LD003PP	1.3-35.5	0.28	0.80	04/17/86	04/17/86
LF001PP	1.3-14.0	0.96	10.30	04/08/86	03/17/86
LF001PP	14.0-37.2	0.04	0.00	03/26/86	NOT REQ.
LF001PP	37.2-58.8	2.18	22.18	04/17/86	04/18/86
LF001SS	2.4-39.8	1.17	5.18	04/08/86	04/08/86
LF001SS	39.8-61.2	0.10	0.00	04/22/86	NOT REQ.
LF002PP	2.4-13.3	0.81	0.40	03/13/86	03/17/86
LF002PP	13.3-38.8	0.17	0.00	03/26/86	NOT REQ.
LF002PP	38.8-60.1	0.05	0.00	04/17/86	NOT REQ.
LF002SS	2.4-38.8	1.20	0.72	04/08/86	04/08/86
LF002SS	38.8-60.1	0.26	0.72	04/22/86	NO RECOR
LF003PP	1.3-25.0	0.61	0.55	03/18/86	03/17/86
LF003PP	16.1-38.8	0.03	0.00	03/26/86	NOT REQ.
LF003PP	38.8-60.1	0.10	0.00	04/17/86	NOT REQ.
LF003SS	2.4-38.8	0.18	0.10	04/08/86	04/08/86
LF003SS	38.8-60.1	0.02	0.00	04/22/86	NOT REQ.
LF004PP	1.3-14.8	0.01	0.00	03/13/86	NOT REQ.
LF004PP	14.8-39.4	1.05	9.85	03/26/86	03/27/86
LF004PP	39.4-60.6	0.00	0.00	04/17/86	NOT REQ.
LF004SS	1.3-38.3	1.26	0.71	04/08/86	04/08/86
LF004SS	39.4-60.6	0.59	0.71	04/22/86	NO RECOR
LF005PP	1.3-15.2	0.06	0.00	03/13/86	NOT REQ.
LF005PP	15.2-38.8	0.68	1.17	03/26/86	03/27/86
LF005PP	38.8-60.1	0.03	0.00	04/17/86	NOT REQ.
LF005SS	1.3-39.4	0.04	0.09	04/08/86	04/08/86
LF005SS	38.3-59.6	0.02	0.00	04/22/86	NOT REQ.
LF006PP	1.3-15.3	0.14	0.00	03/13/86	NOT REQ.
LF006PP	15.3-38.0	0.44	1.66	03/26/86	03/27/86
LF006PP	38.0-59.4	0.15	0.00	04/17/86	NOT REQ.
LF006SS	1.3-38.3	0.58	2.98	04/08/86	04/09/86
LF006SS	38.3-59.1	0.07	0.00	04/22/86	NOT REQ.
LF007PP	1.3-15.1	0.03	0.00	03/13/86	NOT REQ.
LF007PP	15.1-38.3	0.06	0.00	03/26/86	NOT REQ.
LF007PP	38.3-59.1	0.03	0.00	04/17/86	NOT REQ.
LF007SS	1.3-38.6	0.12	0.00	04/08/86	NOT REQ.
LF007SS	38.6-59.9	0.37	1.43	04/22/86	04/23/86
LF008PP	1.3-15.4	0.08	0.51	03/13/86	03/17/86
LF008PP	15.4-39.3	0.39	2.14	03/26/86	03/27/86
LF008PP	39.3-61.2	0.80	7.07	04/17/86	04/18/86
LF008SS	1.3-40.4	0.50	3.63	04/08/86	04/09/86
LF008SS	40.4-62.8	0.05	0.00	04/22/86	NOT REQ.
LF009PP	1.3-16.4	0.34	3.43	03/13/86	03/17/86
LF009PP	16.4-42.3	0.06	0.00	03/26/86	NOT REQ.
LF009PP	42.3-65.4	0.00	0.00	04/17/86	NOT REQ.
LL001PP	1.3-43.5	0.10	0.00	03/27/86	NOT REQ.
LL001PP	43.5-47.7	0.10	0.00	04/15/86	NOT REQ.

LL001PP	47.7-65.9	0.13	0.00	04/15/86	NOT REQ.
LL001SS	1.3-43.5	1.74	0.85	04/07/86	04/08/86
LL001SS	43.5-65.9	0.54	0.28	04/22/86	04/22/86
LL002PP	1.3-33.2	0.43	0.33	03/27/86	03/31/86
LL002PP	33.2-43.5	0.13	0.00	04/03/86	NOT REQ.
LL002PP	43.5-65.9	0.09	0.00	04/15/86	NOT REQ.
LL002SS	1.3-43.5	1.22	0.08	04/07/86	04/08/86
LL002SS	43.5-65.9	0.25	0.13	04/22/86	04/22/86
LL003PP	1.3-15.5	0.94	0.33	03/27/86	03/27/86
LL003PP	15.5-43.5	0.02	0.00	04/03/86	NOT REQ.
LL003PP	43.5-65.9	0.05	0.00	04/15/86	NOT REQ.
LL003SS	1.3-43.5	0.08	0.00	04/07/86	NOT REQ.
LL003SS	43.5-65.9	0.09	0.00	04/22/86	NOT REQ.
LL004PP	1.3-43.5	0.14	0.00	03/27/86	NOT REQ.
LL004PP	43.5-65.9	0.06	0.00	04/15/86	NOT REQ.
LL004SS	1.3-43.5	0.33	0.66	04/07/86	04/08/86
LL004SS	43.5-65.9	0.23	1.00	04/22/86	04/22/86
LL005PP	1.3-20.5	0.29	2.91	03/27/86	03/31/86
LL005PP	20.5-43.5	0.32	1.00	04/03/86	04/03/86
LL005PP	43.5-65.9	0.10	0.00	04/15/86	NOT REQ.
LL005SS	1.3-43.5	0.27	0.43	04/07/86	04/08/86
LL005SS	43.5-65.9	0.02	0.00	04/22/86	NOT REQ.
LL005T1	1.3-15.7	0.01	0.00	04/24/86	NOT REQ.
LL005T1	15.7-33.9	0.41	1.50	05/01/86	05/02/86
LL005T1	33.9-38.2	0.17	0.00	05/05/86	NOT REQ.
LL005T2	1.3-15.7	0.01	0.00	04/24/86	NOT REQ.
LL005T2	15.7-38.2	0.09	0.00	05/01/86	NOT REQ.
LL006PP	1.3-19.5	2.31	12.28	03/27/86	03/31/86
LL006PP	19.5-43.5	0.08	0.00	04/03/86	NOT REQ.
LL006PP	43.5-65.9	0.31	0.68	04/15/86	04/15/86
LL006SS	1.3-43.5	0.02	0.00	04/07/86	NOT REQ.
LL006SS	43.5-65.9	0.05	0.00	04/22/86	NOT REQ.
LL006T1	1.3-15.7	0.03	0.00	04/24/86	NOT REQ.
LL006T1	15.7-38.2	0.09	0.00	05/01/86	NOT REQ.
LL006T2	1.3-15.7	0.08	0.00	04/24/86	NOT REQ.
LL006T2	15.7-38.2	0.16	0.00	05/01/86	NOT REQ.
LL007PP	1.3-17.0	2.30	15.23	03/27/86	03/31/86
LL007PP	17.0-43.5	0.02	0.00	04/03/86	NOT REQ.
LL007PP	43.5-65.9	0.09	0.00	04/15/86	NOT REQ.
LL007SS	1.3-43.5	0.01	0.00	04/07/86	NOT REQ.
LL007SS	43.5-65.9	0.10	0.00	04/22/86	NOT REQ.
LL007T1	1.3-15.1	0.01	0.00	04/25/86	NOT REQ.
LL007T1	15.1-38.2	0.04	0.00	05/01/86	NOT REQ.
LL007T2	1.3-16.3	0.04	0.00	04/25/86	NOT REQ.
LL007T2	16.3-39.3	0.05	0.00	05/01/86	NOT REQ.
LL008PP	1.3-19.9	2.33	0.15	03/27/86	03/31/86
LL008PP	19.9-43.5	0.01	0.00	04/03/86	NOT REQ.
LL008PP	43.5-65.5	0.02	0.00	04/15/86	NOT REQ.
LL008SS	1.3-51.1	0.06	0.00	04/07/86	NOT REQ.
LL008SS	51.1-73.5	0.27	0.00	04/22/86	04/22/86
LL008T1	1.3-20.0	0.07	0.00	04/25/86	NOT REQ.
LL008T1	20.0-43.5	0.10	0.00	05/01/86	NOT REQ.
LL008T2	1.3-21.8	0.07	0.34	04/25/86	04/25/86
LL008T2	21.8-47.7	0.02	0.00	05/01/86	NOT REQ.
LL009PP	1.3-54.4	0.21	3.65	03/27/86	03/31/86
LL009PP	54.4-76.9	0.01	0.00	04/15/86	NOT REQ.
LL009SS	1.3-54.4	0.04	0.00	04/07/86	NOT REQ.

LL009SS	54.4-76.9	0.06	0.00	04/22/86	NOT REQ.
LL009T1	1.3-26.0	0.43	0.70	04/25/86	04/25/86
LL009T1	26.0-48.8	0.06	0.00	05/01/86	NOT REQ.
LL009T2	1.3-27.2	0.01	0.00	04/25/86	NOT REQ.
LL009T2	27.2-48.8	0.01	0.00	05/01/86	NOT REQ.
LL010PP	1.3-55.0	0.21	0.22	03/27/86	03/15/86
LL010PP	55.0-77.4	0.02	0.00	04/15/86	NOT REQ.
LL010SS	1.3-55.0	0.07	0.00	04/07/86	NOT REQ.
LL010SS	55.0-77.4	0.06	0.00	04/22/86	NOT REQ.
LL010T1	1.3-27.5	0.01	0.00	04/25/86	NOT REQ.
LL010T1	27.5-49.4	0.02	0.00	05/01/86	NOT REQ.
LL010T2	1.3-27.1	0.11	0.00	04/25/86	NOT REQ.
LL010T2	27.1-55.0	0.14	0.28	05/01/86	05/02/86
LL011PP	1.3-55.0	1.90	17.50	03/27/86	03/27/86
LL011PP	55.0-77.4	0.45	1.00	04/15/86	04/15/86
LL011Q1	1.3-55.0	0.19	0.00	05/07/86	NOT REQ.
LL011Q2	1.3-55.0	0.16	0.00	05/07/86	NOT REQ.
LL011SS	1.3-55.0	0.79	8.44	04/07/86	04/07/86
LL011SS	55.0-77.4	0.06	0.00	04/22/86	NOT REQ.
LL011T1	1.3-25.6	0.16	0.00	04/25/86	NOT REQ.
LL011T1	26.9-55.0	0.51	4.35	05/01/86	05/02/86
LL011T2	1.3-26.1	0.05	0.00	04/25/86	NOT REQ.
LL011T2	27.4-58.0	0.36	0.90	05/01/86	05/02/86
LL012PP	1.3-21.2	1.89	6.98	02/27/86	02/28/86
LL012PP	26.8-34.3	1.81	21.88	03/05/86	03/05/86
LL012PP	34.3-55.0	0.59	3.71	03/07/86	03/07/86
LL012PP	55.0-77.4	0.15	0.00	03/19/86	NOT REQ.
LL012SS	1.3-34.1	0.34	1.20	03/12/86	03/12/86
LL012SS	34.1-55.3	0.37	1.09	03/14/86	03/14/86
LL012SS	55.3-77.7	0.06	0.00	03/25/86	NOT REQ.
LL013PP	1.3-26.2	1.91	1.74	02/27/86	02/28/86
LL013PP	26.2-33.1	1.80	14.01	03/05/86	03/05/86
LL013PP	33.1-40.1	0.57	0.55	03/07/86	03/07/86
LL013PP	40.1-55.3	0.28	0.95	03/10/86	03/10/86
LL013PP	55.3-76.0	0.08	0.00	03/19/86	NOT REQ.
LL013Q1	1.3-55.0	0.37	0.92	05/07/86	05/07/86
LL013Q2	1.3-55.0	0.77	2.53	05/07/86	05/07/86
LL013SS	1.3-36.4	0.26	1.18	03/12/86	03/12/86
LL013SS	36.4-54.6	1.40	5.36	03/14/86	03/14/86
LL013SS	54.6-74.4	0.10	0.00	03/25/86	NOT REQ.
LL013T1	1.3-28.2	1.20	7.30	04/25/86	04/25/86
LL013T1	28.2-40.0	0.26	6.05	05/02/86	05/02/86
LL013T1	40.0-55.0	0.10	0.00	05/05/86	NOT REQ.
LL013T2	1.3-29.4	0.02	0.00	04/25/86	NOT REQ.
LL013T2	29.4-39.1	0.39	0.00	05/02/86	05/02/86
LL013T2	39.1-54.8	0.13	0.00	05/05/86	NOT REQ.
LL014PP	1.3-54.9	1.11	69.68	02/27/86	02/28/86
LL014PP	54.9-74.6	0.12	0.00	03/19/86	NOT REQ.
LL014SS	1.3-56.6	1.90	11.26	03/12/86	03/12/86
LL014SS	56.6-76.3	0.00	0.10	03/25/86	03/25/86
LL014T1	1.3-27.6	0.10	0.00	04/25/86	NOT REQ.
LL014T1	27.6-55.8	0.05	0.00	05/02/86	05/02/86
LL014T2	1.3-57.6	0.27	2.23	04/30/86	04/30/86
LL015PP	1.3-58.5	0.67	5.60	02/27/86	02/28/86
LL015PP	58.5-78.3	1.10	14.00	03/19/86	03/19/86
LL015SS	1.3-56.6	0.03	0.19	03/12/86	03/12/86
LL015SS	56.6-77.3	0.00	1.00	03/25/86	03/25/86

LL015T1	1.3-57.6	0.11	0.00	04/30/86	NOT REQ.
LL015T2	1.3-56.1	0.39	0.00	04/30/86	04/30/86
LL016PP	1.3-55.6	1.79	8.15	02/27/86	02/28/86
LL016PP	55.6-75.1	0.53	10.50	03/19/86	03/19/86
LL016Q1	1.3-56.0	0.06	0.00	05/05/86	NOT REQ.
LL016Q2	1.3-57.2	0.01	0.00	05/05/86	NOT REQ.
LL016SS	1.3-57.7	2.02	27.83	03/12/86	03/12/86
LL016SS	57.7-77.2	0.05	0.00	03/25/86	NOT REQ.
LL016T1	1.3-56.7	1.65	10.72	04/30/86	04/30/86
LL016T2	1.3-58.6	0.67	0.23	04/30/86	04/30/86
LL017PP	1.3-56.1	1.84	14.08	02/27/86	02/28/86
LL017PP	56.1-59.5	0.03	0.00	03/05/86	NOT REQ.
LL017PP	59.5-78.0	0.13	0.00	03/19/86	NOT REQ.
LL017SS	1.3-58.5	0.11	0.00	03/12/86	NOT REQ.
LL017SS	58.5-76.5	0.07	0.00	03/25/86	NOT REQ.
LL017T1	1.3-59.0	0.01	0.00	04/30/86	NOT REQ.
LL017T2	1.3-58.1	0.13	0.00	04/30/86	NOT REQ.
LL018PP	1.3-57.7	1.83	10.92	02/27/86	03/03/86
LL018PP	57.7-75.8	0.01	0.00	03/19/86	NOT REQ.
LL018SS	1.3-57.6	1.15	18.41	03/12/86	03/12/86
LL018SS	57.6-75.9	1.23	3.97	03/25/86	03/25/86
LL018T1	1.3-57.7	0.10	0.00	04/30/86	NOT REQ.
LL018T2	1.3-58.0	0.15	0.00	04/30/86	NOT REQ.
LL019PP	1.3-58.3	1.48	8.13	02/27/86	03/03/86
LL019PP	58.3-76.4	0.05	0.00	03/19/86	NOT REQ.
LL019SS	1.3-54.9	0.24	1.89	03/12/86	03/12/86
LL019SS	54.9-73.0	0.04	0.00	03/25/86	NOT REQ.
LL019T1	1.3-56.6	0.19	0.73	04/30/86	04/30/86
LL019T2	1.3-53.6	0.06	0.00	04/30/86	NOT REQ.
LL020PP	1.3-46.1	1.85	26.38	02/27/86	02/28/86
LL020PP	47.4-52.8	0.06	0.00	03/05/86	NOT REQ.
LL020PP	52.8-70.4	0.06	0.00	03/19/86	NOT REQ.
LL020SS	1.3-49.4	0.23	0.84	03/12/86	03/12/86
LL020SS	49.4-67.5	0.24	3.54	03/25/86	03/25/86
LL020T1	1.3-50.9	0.11	0.00	04/30/86	NOT REQ.
LL020T2	1.3-49.4	0.18	0.00	04/30/86	NOT REQ.
LL021PP	1.3-49.4	1.83	38.54	02/27/86	03/03/86
LL021PP	49.4-67.8	1.11	27.60	03/19/86	03/20/86
LL021SS	1.3-47.8	0.23	2.00	04/11/86	04/14/86
LL021SS	47.8-67.6	0.18	0.00	04/23/86	NOT REQ.
LL022PP	1.3-48.5	0.45	4.60	04/02/86	04/02/86
LL022PP	48.5-68.5	1.50	0.31	04/17/86	04/17/86
LL022SS	1.3-50.1	0.02	0.00	04/11/86	NOT REQ.
LL022SS	50.1-70.1	0.14	0.00	04/23/86	NOT REQ.
LL022T2	1.3-27.8	0.05	0.00	04/30/86	NOT REQ.
LL023PP	1.3-15.4	1.29	53.75	04/02/86	04/02/86
LL023PP	15.9-52.1	0.97	7.56	04/07/86	04/08/86
LL023PP	52.1-72.2	0.42	31.42	04/17/86	04/17/86
LL023SS	1.3-50.8	0.17	0.00	04/11/86	NOT REQ.
LL023SS	50.8-70.9	1.12	15.00	04/23/86	04/23/86
LL023T1	1.3-71.5	0.30	0.88	04/30/86	04/30/86
LL023T2	1.3-70.0	0.98	1.86	04/30/86	04/30/86
LL024PP	1.3-49.4	0.53	8.05	04/02/86	04/02/86
LL024PP	49.4-69.4	2.01	72.00	04/17/86	04/17/86
LL024SS	1.3-47.8	0.30	0.90	04/11/86	04/14/86
LL024SS	47.8-67.8	0.05	0.00	04/23/86	NOT REQ.
LL025PP	1.3-49.0	1.10	7.20	04/02/86	04/02/86

LL025PP	49.0-69.0	0.21	17.30	04/17/86	04/17/86
LL025SS	1.3-50.8	1.24	7.00	04/11/86	04/14/86
LL025SS	50.8-69.9	0.09	0.00	04/23/86	NOT REQ.
LL025T1	1.3-49.9	0.66	0.31	04/30/86	04/30/86
LL025T2	1.3-51.3	0.22	0.98	04/30/86	04/30/86
LL026PP	1.3-51.8	0.27	0.33	04/02/86	04/02/86
LL026PP	51.8-70.9	1.82	31.18	04/17/86	04/17/86
LL026SS	1.3-50.5	0.55	4.65	04/11/86	04/11/86
LL026SS	50.5-69.4	0.32	0.80	04/23/86	04/23/86
LL026T2	1.3-26.8	0.09	0.00	04/30/86	NOT REQ.
LL027PP	1.3-51.4	1.25	5.21	04/02/86	04/02/86
LL027PP	51.4-61.0	1.73	9.28	04/17/86	04/17/86
LL027PP	51.4-70.5	0.15	0.00	04/21/86	NOT REQ.
LL027SS	1.3-49.0	0.18	0.00	04/11/86	NOT REQ.
LL027SS	49.0-68.1	0.16	0.00	04/23/86	NOT REQ.
LL028PP	1.3-46.6	1.07	10.53	04/02/86	04/02/86
LL028PP	46.6-59.0	2.03	33.58	04/17/86	04/18/86
LL028PP	59.0-65.5	0.07	0.00	04/21/86	NOT REQ.
LL028SS	1.3-44.3	0.30	0.37	04/11/86	04/14/86
LL028SS	44.3-63.3	0.44	1.14	04/23/86	04/23/86
LL029PP	1.3-42.3	0.08	0.00	04/02/86	NOT REQ.
LL029PP	42.3-61.3	1.89	118.41	04/17/86	04/18/86
LL029SS	1.3-40.0	0.18	0.00	04/11/86	NOT REQ.
LL029SS	40.0-60.4	0.07	0.00	04/23/86	NOT REQ.
LL030PP	1.3-38.2	0.35	1.78	04/02/86	04/02/86
LL030PP	38.2-60.1	1.09	18.47	04/17/86	04/18/86
LL030SS	1.3-37.6	0.13	0.00	04/11/86	NOT REQ.
LL030SS	37.6-58.6	0.07	0.00	04/23/86	NOT REQ.
LS001PP	18.8-37.2	0.93	0.51	05/22/86	05/23/86
LS001SS	21.3-37.2	0.18	0.00	05/28/86	NOT REQ.
LS002PP	21.4-37.3	0.12	0.00	05/22/86	NOT REQ.
LS002SS	21.4-37.3	1.60	0.00	05/28/86	05/29/86
LS003PP	21.3-37.2	0.03	0.00	05/22/86	NOT REQ.
LS003SS	21.2-37.1	0.00	0.00	05/28/86	NOT REQ.
LS004PP	21.1-37.0	1.20	23.27	05/22/86	05/23/86
LS004SS	20.8-36.7	0.00	0.00	05/28/86	NOT REQ.
LS005PP	20.5-36.4	0.00	0.00	05/22/86	NOT REQ.
LS005SS	21.2-37.1	0.28	2.86	05/28/86	05/29/86
LS006PP	20.1-36.0	1.21	13.08	05/22/86	05/23/86
LS006SS	20.0-35.9	0.09	0.00	05/28/86	NOT REQ.
LS007PP	20.0-35.9	0.00	0.00	05/22/86	NOT REQ.
LS007SS	19.8-35.7	0.13	0.00	05/28/86	NOT REQ.
LS008PP	19.9-35.8	0.41	1.00	05/22/86	05/23/86
LS008SS	19.9-35.8	0.08	0.00	05/28/86	NOT REQ.
LS009PP	19.8-35.7	0.13	0.00	05/22/86	NOT REQ.
LS009SS	18.6-27.9	0.00	0.00	05/28/86	NOT REQ.
LS010PP	18.9-37.0	1.10	10.88	05/22/86	05/23/86
LS010SS	19.9-49.7	0.13	0.00	05/28/86	NOT REQ.
LS011PP	20.7-49.4	0.29	0.12	05/22/86	05/23/86
LS011SS	20.2-48.9	0.12	1.07	05/28/86	05/29/86
RF001PP	1.3-41.5	1.78	17.13	02/19/86	02/13/86
RF001PP	41.5-63.9	0.02	0.00	03/05/86	NOT REQ.
RF001SS	2.4-41.5	0.04	0.00	02/25/86	03/13/86
RF001SS	41.5-63.9	1.50	3.26	03/13/86	03/13/86
RF002PP	1.3-43.0	0.82	0.55	02/19/86	02/19/86
RF002PP	43.0-65.4	0.05	0.00	03/05/86	NOT REQ.
RF002SS	2.4-38.2	1.31	18.91	02/25/86	02/25/86

RF002SS	38.2-43.2	0.00	0.00	02/28/86	NOT REQ.
RF002SS	43.2-65.6	1.52	0.22	03/13/86	03/13/86
RF003PP	1.3-41.8	0.26	0.16	02/12/86	02/13/86
RF003PP	41.8-64.2	0.60	0.84	03/05/86	03/06/86
RF003SS	2.4-37.9	1.29	12.99	02/25/86	02/25/86
RF003SS	37.9-43.0	0.01	0.00	02/28/86	NOT REQ.
RF003SS	43.0-63.9	1.52	0.13	03/13/86	03/13/86
RF004PP	1.3-12.4	0.02	0.00	02/12/86	NOT REQ.
RF004PP	12.4-41.5	1.76	6.47	02/19/86	02/19/86
RF004PP	41.5-54.4	1.41	144.98	03/05/86	03/07/86
RF004PP	54.4-63.9	0.08	0.00	03/10/86	NOT REQ.
RF004SS	1.3-41.5	0.38	0.78	02/25/86	02/26/86
RF004SS	41.5-65.4	0.23	1.39	03/13/86	03/13/86
RF005PP	1.3-11.7	0.72	2.52	02/12/86	02/13/86
RF005PP	11.7-41.5	0.05	0.00	02/19/86	NOT REQ.
RF005PP	41.5-63.9	0.99	3.59	03/05/86	03/06/86
RF005SS	1.3-41.5	0.42	0.84	02/25/86	02/26/86
RF005SS	41.5-63.9	0.32	2.64	03/13/86	03/13/86
RF006PP	1.3-10.7	1.20	3.30	02/12/86	02/13/86
RF006PP	10.7-41.0	0.00	0.00	02/19/86	NOT REQ.
RF006PP	41.0-63.4	0.06	0.00	03/05/86	NOT REQ.
RF006SS	1.3-40.4	0.37	0.16	02/25/86	02/26/86
RF006SS	40.4-62.8	0.34	0.40	03/13/86	03/13/86
RF007PP	1.3-13.2	0.55	0.18	02/12/86	02/13/86
RF007PP	13.2-40.4	0.11	0.00	02/19/86	NOT REQ.
RF007PP	40.4-62.8	1.41	35.12	03/05/86	03/06/86
RF007SS	1.3-40.9	0.47	0.89	02/25/86	02/26/86
RF007SS	40.9-63.4	0.27	1.35	03/13/86	03/13/86
RF008PP	1.3-12.8	0.03	0.00	02/12/86	NOT REQ.
RF008PP	12.8-41.6	1.18	15.21	02/19/86	02/19/86
RF008PP	41.6-64.5	1.41	24.08	03/05/86	03/06/86
RF008SS	1.3-21.5	0.14	0.00	02/25/86	NOT REQ.
RF008SS	21.5-42.6	0.08	0.00	02/28/86	NOT REQ.
RF008SS	42.6-66.2	0.10	0.00	03/13/86	NOT REQ.
RF009PP	1.3-12.3	0.00	0.00	02/12/86	NOT REQ.
RF009PP	12.3-43.7	3.45	16.34	02/19/86	02/19/86
RF009PP	43.7-68.5	0.89	1.87	03/05/86	03/06/86
RF009SS	1.3-45.4	0.48	0.34	02/25/86	02/26/86
RF009SS	45.4-70.7	0.11	0.00	03/13/86	NOT REQ.
RF010PP	1.3-13.3	0.27	0.57	02/12/86	02/13/86
RF010PP	13.3-47.7	1.39	0.17	02/19/86	02/19/86
RF010PP	47.7-74.4	0.99	5.19	03/05/86	03/06/86
RR001PP	11.7-18.1	1.20	1.50	01/22/86	01/22/86
RR001PP	18.1-43.5	0.26	0.56	01/27/86	01/27/86
RR001PP	43.5-65.9	0.04	0.00	02/04/86	NOT REQ.
RR001SS	1.3-43.5	1.00	1.58	01/30/86	01/31/86
RR001SS	43.5-65.9	0.09	0.00	02/06/86	NOT REQ.
RR002PP	1.3-14.8	0.26	3.00	01/15/86	01/16/86
RR002PP	14.8-19.1	2.45	7.10	01/22/86	01/22/86
RR002PP	19.1-43.5	0.17	0.00	01/27/86	NOT REQ.
RR002PP	43.5-65.9	0.08	0.00	02/04/86	NOT REQ.
RR002SS	1.3-40.8	0.42	0.62	01/30/86	01/31/86
RR002SS	40.8-65.9	0.03	0.00	02/06/86	NOT REQ.
RR003PP	1.3-13.0	1.30	40.50	01/15/86	01/15/86
RR003PP	13.0-18.2	2.48	5.40	01/22/86	01/2[illegible]
RR003PP	18.2-30.9	0.26	0.22	01/27/86	01/2[illegible]
RR003PP	30.9-43.5	0.07	0.00	01/28/86	NOT [illegible]

RR003PP	43.5-65.9	1.46	0.11	02/04/86	02/04/86
RR003SS	1.3-43.5	0.56	0.92	01/30/86	01/31/86
RR003SS	43.5-65.9	0.04	0.00	02/06/86	NOT REQ.
RR004PP	1.3-13.2	0.59	5.00	01/15/86	01/16/86
RR004PP	13.2-23.6	0.16	0.25	01/22/86	01/22/86
RR004PP	23.6-43.5	0.15	0.00	01/27/86	NOT REQ.
RR004PP	43.5-65.9	1.65	3.33	02/04/86	02/04/86
RR004SS	1.3-43.5	0.39	0.37	01/30/86	01/31/86
RR004SS	43.5-65.9	0.05	0.00	02/06/86	NOT REQ.
RR005PP	1.3-13.2	2.49	3.00	01/15/86	01/17/86
RR005PP	13.2-21.5	0.98	15.50	01/22/86	01/22/86
RR005PP	21.5-34.9	0.40	0.81	01/27/86	01/27/86
RR005PP	34.9-43.1	0.12	0.00	01/28/86	NOT REQ.
RR005PP	43.1-65.6	0.15	0.00	02/04/86	NOT REQ.
RR005SS	1.3-48.2	0.34	1.51	01/31/86	01/31/86
RR005SS	48.2-65.6	0.02	0.00	02/06/86	NOT REQ.
RR006PP	1.3-13.2	0.68	2.00	01/15/86	01/16/86
RR006PP	13.2-43.8	0.24	0.60	01/22/86	01/22/86
RR006PP	43.8-65.6	0.04	0.00	02/04/86	NOT REQ.
RR006SS	1.3-31.4	0.10	0.80	01/30/86	01/31/86
RR006SS	31.4-43.2	0.43	0.00	01/31/86	NO RECOR
RR006SS	43.2-65.6	0.13	0.00	02/06/86	NOT REQ.
RR007PP	1.3-16.2	0.00	0.00	01/15/86	NOT REQ.
RR007PP	16.2-29.2	0.05	0.00	01/22/86	01/22/86
RR007PP	29.2-43.2	0.02	0.00	01/28/86	NOT REQ.
RR007PP	43.2-65.6	0.07	0.00	02/04/86	NOT REQ.
RR007SS	1.3-36.4	0.44	0.64	01/31/86	01/31/86
RR007SS	36.4-58.9	0.04	0.00	02/06/86	NOT REQ.
RR008PP	1.3-14.2	0.35	4.00	01/15/86	01/17/86
RR008PP	14.2-30.0	0.42	1.00	01/22/86	01/22/86
RR008PP	30.0-43.2	0.21	1.00	01/27/86	NO RECOR
RR008PP	43.2-65.6	0.18	0.00	02/04/86	NOT REQ.
RR008SS	1.3-43.2	0.58	0.46	01/31/86	01/31/86
RR008SS	43.2-65.6	0.15	0.00	02/06/86	NOT REQ.
RR009PP	1.3-13.9	0.00	0.00	01/15/85	NOT REQ.
RR009PP	13.9-43.0	0.27	1.50	01/22/86	01/22/86
RR009PP	43.0-65.6	0.06	0.00	02/04/86	NOT REQ.
RR009SS	1.3-43.2	0.34	0.88	01/31/86	01/31/86
RR009SS	43.2-65.6	0.11	0.00	02/06/86	NOT REQ.
RR010PP	1.3-14.2	0.05	0.50	01/15/86	01/17/86
RR010PP	14.2-43.1	0.35	0.35	01/22/86	01/22/86
RR010PP	43.1-65.7	0.11	0.00	02/04/86	NOT REQ.
RR010SS	1.3-43.2	0.25	1.05	01/31/86	01/31/86
RR010SS	43.2-65.6	0.07	0.00	02/06/86	NOT REQ.
RR011PP	1.3-13.5	0.06	0.50	01/15/86	01/16/86
RR011PP	13.5-43.2	0.12	0.50	01/22/86	01/22/86
RR011PP	43.2-66.7	0.11	0.00	02/04/86	NOT REQ.
RR011SS	1.3-43.2	0.28	0.00	02/14/86	NO RECOR
RR011SS	43.2-65.6	0.33	0.60	02/20/86	02/21/86
RR012PP	1.3-11.9	1.92	4.13	02/07/86	02/07/86
RR012PP	11.9-43.2	0.37	3.34	02/10/86	02/10/86
RR012PP	43.2-65.6	0.10	0.00	02/19/86	NOT REQ.
RR012SS	1.3-43.5	0.08	0.00	02/14/86	NOT REQ.
RR012SS	43.5-65.7	0.17	0.00	02/20/86	NOT REQ.
RR013PP	1.3-43.3	1.96	2.05	02/07/86	02/07/86
RR013PP	43.3-65.3	0.20	0.00	02/19/86	NOT REQ.
RR013SS	1.3-43.2	0.14	0.00	02/14/86	NOT REQ.

RR013SS	43.2-65.2	0.17	0.00	02/20/86	NOT REQ.
RR014PP	1.3-28.6	0.87	4.86	02/07/86	02/07/86
RR014PP	28.6-42.9	0.23	0.49	02/10/86	02/10/86
RR014PP	42.9-65.0	0.05	0.00	02/19/86	NOT REQ.
RR014SS	1.3-42.7	0.04	0.00	02/14/86	NOT REQ.
RR014SS	42.7-64.9	0.15	0.00	02/20/86	NOT REQ.
RR015PP	1.3-42.5	0.12	0.23	02/07/86	02/07/86
RR015PP	42.5-64.8	0.07	0.00	02/19/86	NOT REQ.
RR015SS	1.3-42.4	0.01	0.00	02/14/86	NOT REQ.
RR015SS	42.4-64.7	0.17	0.00	02/20/86	NOT REQ.
RR016PP	1.3-19.5	0.66	2.23	02/07/86	02/07/86
RR016PP	19.5-42.5	0.05	0.00	02/10/86	NOT REQ.
RR016PP	42.5-64.8	0.19	0.00	02/19/86	NOT REQ.
RR016SS	1.3-42.5	0.01	0.00	02/14/86	NOT REQ.
RR016SS	42.5-64.5	0.03	0.00	02/20/86	NOT REQ.
RR017PP	1.3-27.1	0.31	0.90	02/07/86	02/07/86
RR017PP	27.1-42.3	0.03	0.00	02/10/86	NOT REQ.
RR017PP	42.3-64.3	0.14	0.00	02/19/86	NOT REQ.
RR017SS	1.3-42.4	0.03	0.00	02/14/86	NOT REQ.
RR017SS	42.4-64.4	0.17	0.00	02/20/86	NOT REQ.
RR018PP	1.3-42.0	0.06	0.00	02/07/86	NOT REQ.
RR018PP	42.0-64.3	0.13	0.00	02/19/86	NOT REQ.
RR018SS	1.3-41.9	0.17	0.00	02/14/86	NOT REQ.
RR018SS	41.9-64.1	1.01	0.79	02/20/86	02/21/86
RR019PP	1.3-41.8	1.96	3.54	02/07/86	02/07/86
RR019PP	41.8-64.0	0.05	0.00	02/19/86	NOT REQ.
RR019SS	1.3-42.0	0.19	0.00	02/14/86	NOT REQ.
RR019SS	42.0-64.1	1.59	0.08	02/20/86	02/21/86
RR020PP	1.3-18.9	1.96	0.27	02/07/86	02/07/86
RR020PP	18.9-41.9	0.02	0.00	02/10/86	NOT REQ.
RR020PP	41.9-63.7	0.05	0.00	02/19/86	NOT REQ.
RR020SS	1.3-41.8	0.01	0.00	02/14/86	NOT REQ.
RR020SS	41.8-63.4	0.11	0.00	02/20/86	NOT REQ.
RR021PP	1.3-41.9	0.04	0.00	02/07/86	NOT REQ.
RR021PP	41.9-63.3	0.09	0.00	02/19/86	NOT REQ.
RR021SS	1.3-45.6	0.06	0.00	02/14/86	NOT REQ.
RR021SS	45.6-67.2	0.14	0.00	02/20/86	NOT REQ.
RR022PP	1.3-9.8	0.07	0.25	01/15/86	01/17/86
RR022PP	9.8-47.0	0.18	0.00	01/23/86	NOT REQ.
RR022PP	47.0-68.5	0.25	0.61	02/03/86	02/03/86
RR022SS	1.3-46.5	0.05	0.00	01/28/86	NOT REQ.
RR022SS	46.5-67.9	0.15	0.00	02/05/86	NOT REQ.
RR023PP	1.3-9.0	1.14	7.00	01/15/86	01/17/86
RR023PP	9.0-18.7	0.24	0.00	01/23/86	NO RECOR
RR023PP	18.7-46.2	0.06	0.00	01/23/86	NOT REQ.
RR023PP	46.2-67.6	0.48	2.00	02/03/86	02/03/86
RR023SS	1.3-14.0	0.95	1.65	01/28/86	01/28/86
RR023SS	14.0-46.6	0.19	0.00	01/31/86	NOT REQ.
RR023SS	46.6-67.1	0.25	1.28	02/05/86	02/05/86
RR024PP	1.3-9.5	0.00	0.00	01/15/86	NOT REQ.
RR024PP	9.5-43.3	0.00	0.00	01/23/86	NOT REQ.
RR024PP	43.3-66.8	0.04	0.00	02/03/86	NOT REQ.
RR024SS	1.3-18.1	0.12	0.00	01/28/86	NOT REQ.
RR024SS	18.1-44.8	0.16	0.00	01/31/86	NOT REQ.
RR024SS	44.8-66.2	1.20	0.91	02/05/86	02/05/86
RR025PP	1.3-9.4	1.21	3.50	01/15/86	01/17/86
RR025PP	9.4-44.5	0.03	0.00	01/23/86	NOT REQ.

RR025PP	44.5-65.9	0.04	0.00	02/03/86	NOT REQ.
RR025SS	1.3-43.9	0.00	0.00	01/28/86	NOT REQ.
RR025SS	43.9-65.5	0.10	0.00	02/05/86	NOT REQ.
RR026PP	1.3-9.6	0.12	0.25	01/15/86	01/17/86
RR026PP	9.6-43.2	0.02	0.00	01/23/86	NOT REQ.
RR026PP	43.2-64.9	0.37	1.22	02/03/86	02/03/86
RR026SS	1.3-43.7	0.61	1.99	01/28/86	01/28/86
RR026SS	43.7-65.1	0.06	0.00	02/05/86	NOT REQ.
RR027PP	1.3-11.5	0.03	0.00	01/15/86	NOT REQ.
RR027PP	11.5-44.2	0.06	0.00	01/23/86	NOT REQ.
RR027PP	44.2-65.7	0.02	0.00	02/03/86	NOT REQ.
RR027SS	1.3-43.9	0.04	0.00	01/28/86	NOT REQ.
RR027SS	43.9-65.4	0.06	0.00	02/05/86	NOT REQ.
RR028PP	1.3-12.0	0.43	2.00	01/15/86	01/17/86
RR028PP	12.0-43.4	0.07	0.00	01/23/86	NOT REQ.
RR028PP	43.4-63.6	0.13	0.00	02/03/86	NOT REQ.
RR028SS	1.3-42.9	0.10	0.00	01/28/86	NOT REQ.
RR028SS	42.9-60.7	0.16	0.00	02/05/86	NOT REQ.
RR029PP	1.3-13.8	0.00	0.00	01/15/86	NOT REQ.
RR029PP	13.8-40.0	0.03	0.00	01/23/86	NOT REQ.
RR029PP	40.0-57.8	0.09	0.00	02/03/86	NOT REQ.
RR029SS	1.3-57.3	0.01	0.00	02/25/86	NOT REQ.
RR029SS	57.3-75.3	0.01	0.00	03/13/86	NOT REQ.
RR029T2	1.3-37.0	0.15	0.00	03/31/86	NOT REQ.
RR030PP	1.3-57.5	1.32	0.47	02/12/86	02/12/86
RR030PP	57.5-75.5	0.15	0.00	03/04/86	NOT REQ.
RR030SS	1.3-58.1	0.87	1.44	02/25/86	02/25/86
RR030SS	58.1-76.1	0.03	0.00	03/13/86	NOT REQ.
RR030T1	1.3-41.5	0.10	0.00	03/31/86	NOT REQ.
RR031PP	1.3-55.3	2.14	10.04	02/12/86	02/12/86
RR031PP	55.3-73.3	0.03	0.00	03/04/86	NOT REQ.
RR031Q3	1.3-42.3	0.03	0.00	03/20/86	NOT REQ.
RR031Q4	1.3-43.5	0.00	0.00	03/20/86	NOT REQ.
RR031SS	1.3-37.0	1.31	17.34	02/25/86	02/25/86
RR031SS	37.0-53.8	0.02	0.00	02/28/86	NOT REQ.
RR031SS	53.8-71.8	0.08	0.00	03/13/86	NOT REQ.
RR031T1	1.3-38.2	0.16	0.00	03/18/86	NOT REQ.
RR031T2	1.3-47.4	0.32	6.00	03/18/86	03/18/86
RR032PP	1.3-54.2	1.33	20.10	02/12/86	02/12/86
RR032PP	54.2-72.4	0.03	0.00	03/04/86	NOT REQ.
RR032Q1	1.3-45.2	0.00	0.00	03/20/86	NOT REQ.
RR032Q2	1.3-47.1	0.01	0.00	03/20/86	NOT REQ.
RR032SS	1.3-38.2	1.33	0.64	02/25/86	02/25/86
RR032SS	38.2-54.1	0.01	0.00	02/28/86	NOT REQ.
RR032SS	54.1-71.3	0.01	0.00	03/13/86	NOT REQ.
RR032T1	1.3-46.0	0.33	14.13	03/18/86	03/18/86
RR032T2	1.3-49.4	0.48	1.87	03/18/86	03/18/86
RR033PP	1.3-52.2	0.56	3.45	02/12/86	02/12/86
RR033PP	52.2-69.0	0.03	0.00	03/04/86	NOT REQ.
RR033SS	1.3-51.3	0.02	0.00	02/25/86	NOT REQ.
RR033SS	51.3-68.0	0.05	0.00	03/13/86	NOT REQ.
RR033T1	1.3-56.8	0.05	0.00	03/18/86	NOT REQ.
RR033T2	1.3-55.2	0.30	0.00	03/18/86	NO RECOR
RR034PP	1.3-50.4	1.03	22.60	02/12/86	02/12/86
RR034PP	50.4-67.0	0.01	0.00	03/05/86	NOT REQ.
RR034SS	1.3-49.9	0.38	0.90	02/25/86	02/25/86
RR034SS	49.9-66.8	0.92	8.80	03/13/86	03/13/86

RR034T1	1.3-60.2	0.07	0.00	03/18/86	NOT REQ.
RR034T2	1.3-61.7	0.09	0.00	03/18/86	NOT REQ.
RR035PP	1.3-45.7	1.29	0.78	02/12/86	02/13/86
RR035PP	45.7-62.6	0.03	0.00	03/05/86	NOT REQ.
RR035SS	1.3-41.9	0.36	0.16	02/25/86	02/25/86
RR035SS	41.9-61.7	0.52	1.66	03/13/86	03/13/86
RR035T1	1.3-61.7	0.06	0.00	03/18/86	NOT REQ.
RR035T2	1.3-61.7	0.10	0.00	03/18/86	NOT REQ.
RR036PP	1.3-32.6	2.56	31.26	02/12/86	02/13/86
RR036PP	32.6-39.6	0.00	0.00	02/19/86	NOT REQ.
RR036PP	39.6-61.1	0.02	0.00	03/05/86	NOT REQ.
RR036SS	1.3-38.8	0.01	0.00	02/25/86	NOT REQ.
RR036SS	38.8-59.8	0.30	1.11	03/13/86	03/13/86
RR036T1	1.3-60.3	0.05	0.00	03/18/86	NOT REQ.
RS001PP	21.3-62.9	0.04	0.00	05/02/86	NOT REQ.
RS001SS	21.0-62.2	0.08	0.00	05/07/86	NOT REQ.
RS002PP	21.0-82.0	0.00	0.00	05/02/86	NOT REQ.
RS002SS	21.0-82.0	0.17	0.00	05/07/86	NOT REQ.
RS003PP	21.0-82.0	0.46	6.66	05/02/86	05/02/86
RS003SS	21.0-82.0	0.07	0.00	05/07/86	NOT REQ.
RS004PP	21.0-82.0	0.15	0.00	05/02/86	NOT REQ.
RS004SS	21.0-48.0	0.01	0.00	05/07/86	NOT REQ.
RS005PP	21.0-82.0	0.18	0.00	05/02/86	NOT REQ.
RS005SS	21.0-48.0	0.02	0.00	05/07/86	NOT REQ.
RS006PP	21.3-48.7	0.01	0.00	05/02/86	NOT REQ.
RS006SS	21.7-49.6	0.09	0.00	05/07/86	NOT REQ.
RS007PP	22.3-51.0	0.07	0.00	05/02/86	NOT REQ.
RS007SS	23.2-53.0	0.02	0.00	05/07/86	NOT REQ.
RS008PP	25.6-51.2	0.03	0.00	05/02/86	NOT REQ.
RS008SS	29.7-44.5	0.04	0.00	05/07/86	NOT REQ.
VV001PP	1.3-33.0	2.25	30.71	02/12/86	02/13/86
VV002PP	1.3-39.0	1.52	6.40	02/12/86	02/12/86
VV004PP	1.3-18.6	0.12	0.00	01/31/86	NOT REQ.
VV013PP	1.3-34.0	0.04	0.00	03/25/86	NOT REQ.
VV014PP	1.3-39.0	0.06	0.00	03/25/86	NOT REQ.
VV015PP	1.3-26.8	0.01	0.00	04/23/86	NOT REQ.
VV016PP	1.3-28.5	0.04	0.00	04/23/86	NOT REQ.

10-01

"K"

DENTAL CONCRETE

Mono. No.	Date	Quantity	Reason
9	05 Jun 84	2 cy	"Faceup" irregular bedding plane face
6/7	15 Jun 84	22 cy	"Faceup" monolith joint face
2/3	09 Aug 84	12 cy	"Faceup" monolith joint face
2-1A	06 Sept 84	6 cy	Fill open joints in foundation floor
11	24 Apr 85	48 cy	Treat fault zone below elevation 985
12	17 May 85	92 cy	Treat fault area below elevation 985
13/14	19 Jun 85	6 cy	Fill sandstone bed undercut
	TOTAL	188 CY	

10 01

"L"

EXPLOSIVES DATA

	SUBJECT	PAGE
1.	Drilling and Blasting Summary	L-2 - L-3
2.	Typical Blasting Reports	L-4 - L-7
3.	Typical Drilling and Loading Plans	L-8 - L-9
4.	Explosive Technical Data	L-10 - L-19
5.	Seismograph Data	L-20 - L-24

10-01

"L-1"

DRILLING AND BLASTING SUMMARY

PRESPLIT

Type Powder - Hercasplit

Hole Diameter - 3 Inch

Spacing - 24 Inch - Load each hole, space powder in hole
18 Inch - Load every other hole, space powder in hole

Caps - Miladet

Stage I (09-27-83 to 05-16-84)

	No. Holes	Range	Avg.	Powder
	18	0.08#/sf - 0.3#/sf	0.16#/sf	2,615#
Stage 2 (12-6-84 to 04-02-85)				
	5	0.11#/sf - 0.28#/sf	0.18#/sf	710#
TOTAL	23	0.08#/sf - 0.30#/sf	0.16#/sf	3,325#

PRODUCTION

Type Powder - Unigel
Hercamix

Hole Diameter - 3-1/2 Inches

Spacing - 7' X 7', 6 X 6, 7 X 8, 8 X 8
4-1/2' X 4-1/2' - To grade w/4-1/2' stemming limestone sand
5 X 5

Burden - 5 Feet (stemming)

Caps - Miladet

Stemming - 5' - 6'

SUMMARY

	No. Holes	Range	Avg.	Powder
Stage 1	38	0.69#/cy - 3.3#/cy	1.70#/cy	33,795#
Stage 2	23	0.30#/cy - 1.6#/cy	0.96#/cy	4,882#
TOTAL	61	0.30#/cy - 3.3#/cy	1.5#/cy	38,677#

TIME 4:37 PM WEATHER Warm APPROX. TEMP 65°

MATS OR OTHER PROTECTIVE DEVICES USED: YES ___ NO ✓

SPECIFIC BLAST LOCATION Monab. ft. #2 + #3

DISTANCE TO NEAREST DWELLING OR STRUCTURE 1000'

TYPE OF MATERIAL BLASTED: SANDSTONE ___ LIMESTONE ___ SHALE ✓ CLAY ___ COAL ___

TOTAL NO. HOLES 23 DIAMETER 3" DEPTH 12' BURDEN ___ SPACING 7½-7½

TYPE OF STEMMING Limestone sand DEPTH OF STEMMING 5'

TYPE OF EXPLOSIVES USED		DELAY CAPS USED	QUANTITY	TYPE OF DELAY USED:
UNIGEL	650 LBS	O-INSTANT	1	ELECTRIC MILADET
HERCAMIX	1250	1-MS-25	1	NON-ELECTRIC
HERCASPLIT		2-MS-50	2	NO. OF SERIES: 3
PRIMACORD		3-MS-75	3	KIND OR MFG: HERCULES
		4-MS-100	2	DETONATOR: 450
TOTAL WGT. OF EXPLOSIVES 2400		5-MS-125	4	TIME SETTING:
		6-MS-150	4	MAX. HOLES/DELAY: 7
		7-MS-175	5	MAX. LBS./DELAY: 230
		8-MS-200	4	MAX. ALLOWABLE LBS./DELAY
		9-MS-250	6	228
		10-MS-300	4	
		11-MS-350	7	
		12-MS-400	3	
		13-MS-450	7	
		14-MS-500	3	
		15-MS-600	5	
		16-MS-700	3	18-MS-900 2
		17-MS-800	3	19-MS-1000 4

William F. [signature]

SIGNATURE OF BLASTER

LICENSE NUMBER OF BLASTER

DISTANCE OF SEISMOGRAPH FROM BLAST ________ FT. DIRECTION N ___ S ___ E ___ W ___

SHOT NO. ________ SEISMOGRAPH OPERATORS NAME ________

WITNESSES ________

VIBRATION MEASUREMENTS

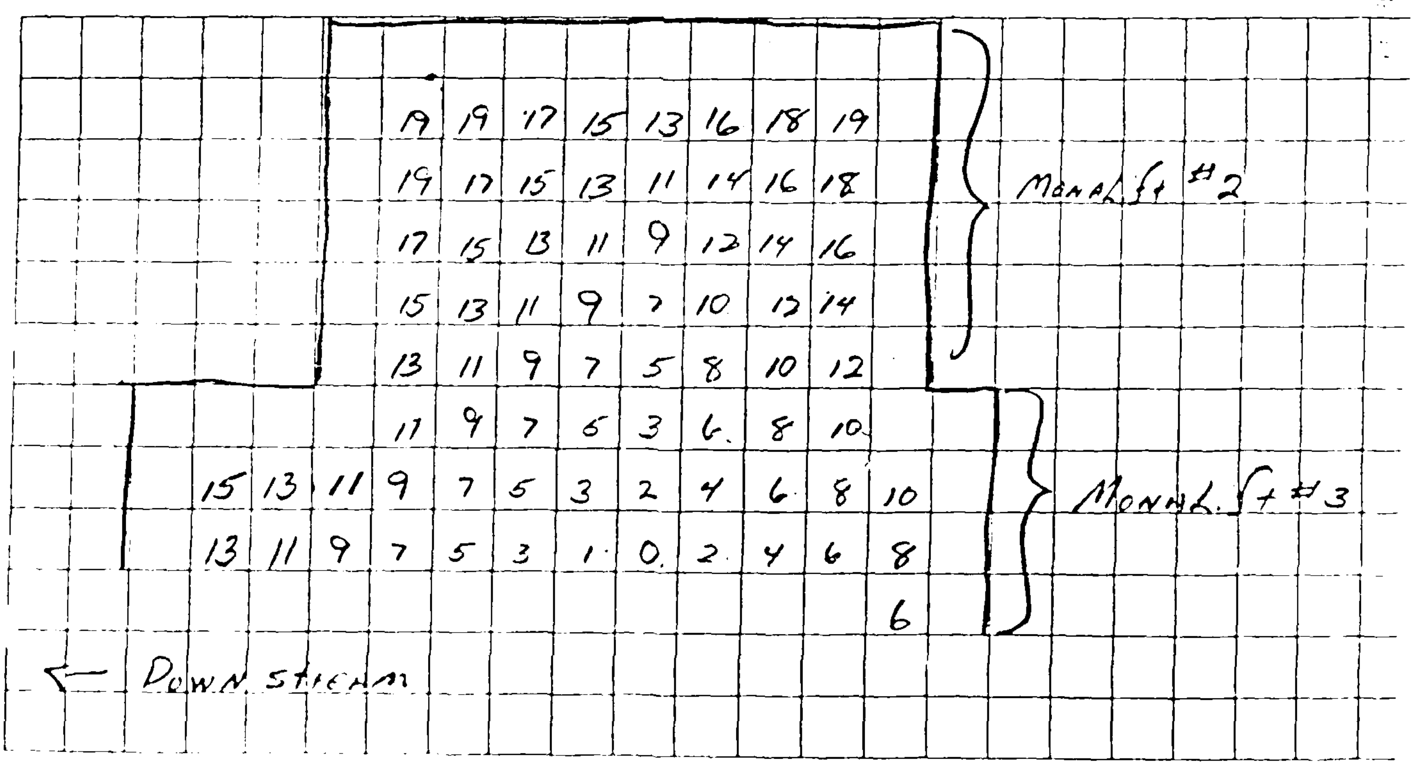
COMPONENT	MONITOR	MAX. PARTICLE VELC
TRANSVERSE		
VERTICAL		
LONGITUDINAL		

AK SOUND PRESSURE LEVEL ________ SCALED DISTANCE ________

IARKS: ________

ANALYZING FIRM ________ ANALYSIS BY ________

DIAGRAM OF SHOT



LOCATION

DATE [illegible] WEATHER Cool APPROX. TEMP [illegible]

MATS OR OTHER PROTECTIVE DEVICES USED: YES ____ NO ✓

SPECIFIC BLAST LOCATION Monolith #2 - #3

DISTANCE TO NEAREST DWELLING OR STRUCTURE 1000'

TYPE OF MATERIAL BLASTED: SANDSTONE ____ LIMESTONE ____ SHALE ✓ CLAY ____ COAL ____

TOTAL NO. HOLES 44 DIAMETER 3" DEPTH 21'-23' BURDEN ____ SPACING 18"

TYPE OF STEMMING Limestone Sand DEPTH OF STEMMING 6"

TYPE OF EXPLOSIVES USED	
UNIGEL	____ LBS
HERCAMIX	
HERCASPLIT	225
PRIMACORD	1000'

TOTAL WGT. OF EXPLOSIVES 225

DELAY CAPS USED	QUANTITY
O-INSTANT	1
1-MS-25	
2-MS-50	
3-MS-75	1
4-MS-100	
5-MS-125	
6-MS-150	1
7-MS-175	
8-MS-200	
9-MS-250	1
10-MS-300	
11-MS-350	
12-MS-400	
13-MS-450	
14-MS-500	
15-MS-600	
16-MS-700	
17-MS-800	
18-MS-900	
19-MS-1000	

TYPE OF DELAY USED:

ELECTRIC MILADET

NON-ELECTRIC ____

NO. OF SERIES: 1

KIND OR MFG: HERCULES

DETONATOR: 450

TIME SETTING: ____

MAX. HOLES/DELAY: 13

MAX. LBS./DELAY: 75

MAX. ALLOWABLE LBS./DELAY

278

William F. Young

SIGNATURE OF BLASTER

____

LICENSE NUMBER OF BLASTER

DISTANCE OF SEISMOGRAPH FROM BLAST ____ FT. DIRECTION: N ____ S ____ E ____ W ____

SHOT NO. ____ SEISMOGRAPH OPERATORS NAME ____

WITNESSES ____

VIBRATION MEASUREMENTS

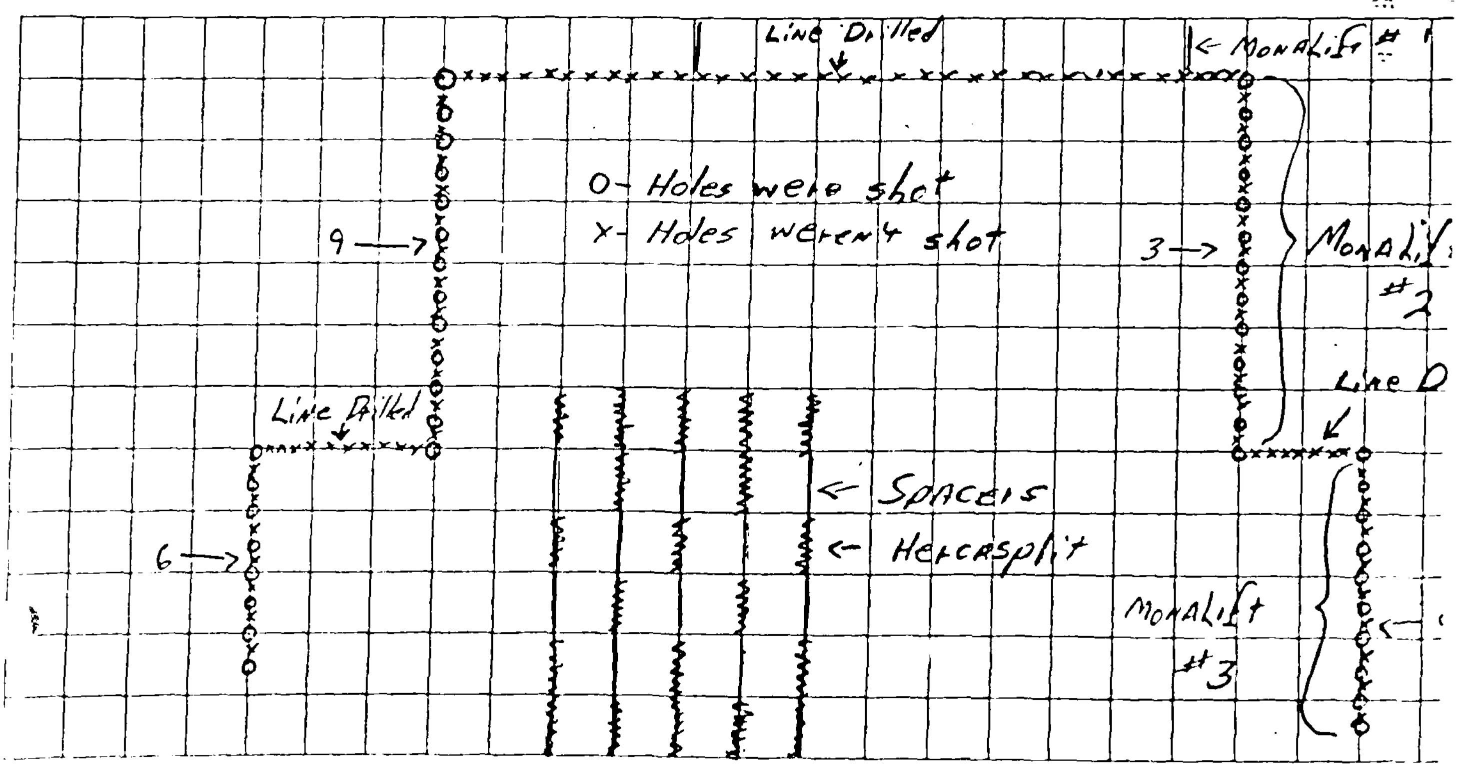
COMPONENT	MONITOR	MAX. PARTICLE VELOCI
TRANSVERSE		
VERTICAL		
LONGITUDINAL		

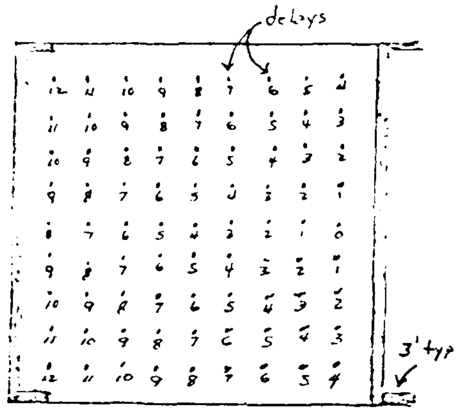
PEAK SOUND PRESSURE LEVEL ____ SCALED DISTANCE ____ FT

REMARKS: ____

ANALYZING FIRM ____ ANALYSIS BY ____

DIAGRAM OF SHOT





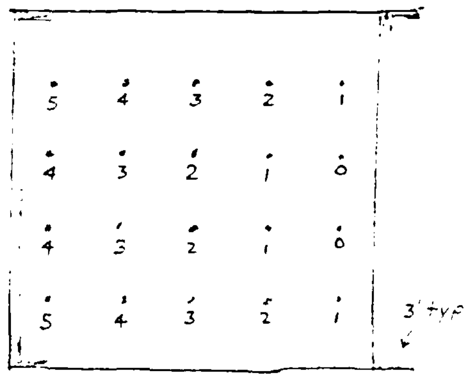
PLAN VIEW

Typical mono. @ 3ft above Found. ELEV.

Linedrilling — 3" ϕ holes; Full depth

Presplit : —— 3" ϕ holes; 18" c to c; Full depth

Production shots = 3" ϕ holes; 5'± c to c; to Founding elev.



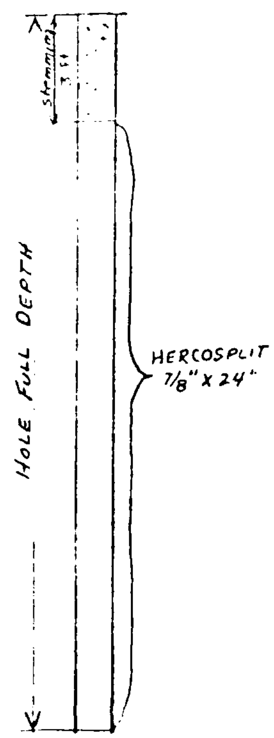
PLAN VIEW

Typical Mono. to 3 ft above Found. Elev.

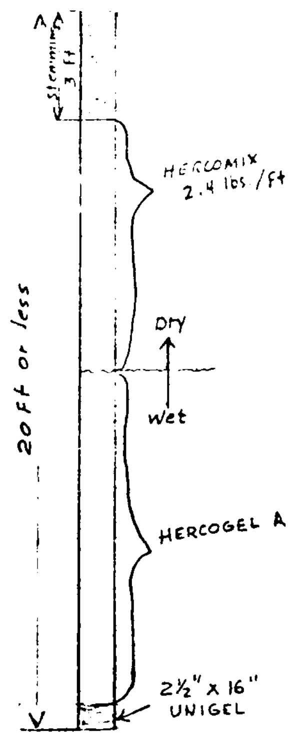
Production shots = 3" ϕ holes; 7'± c to c

Higher mono. Elevations shot first at

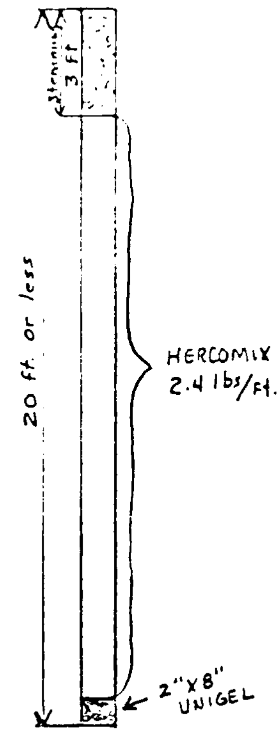
20 ft. maximun lifts



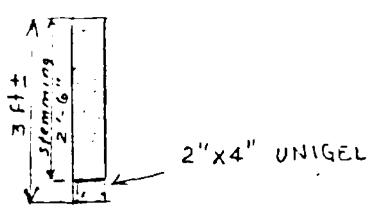
Presplit



WET HOLE



DRY HOLE



PRODUCTION SHOT
3 Ft. Above FOUND. ELEV.

HERCOSPLITTING*

A precision blasting technique that controls overbreak, increases safety, and produces economies in manpower and concreting

HERCULES

EXPLOSIVES & CHEMICAL PROPULSION DEPARTMENT

HERCULES INCORPORATED

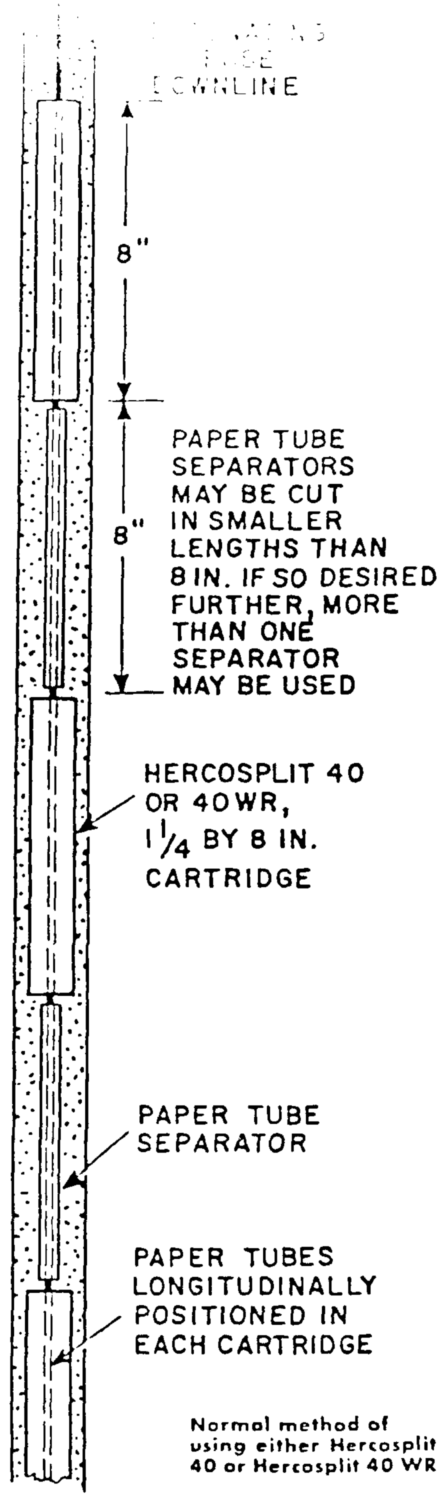
WILMINGTON • DELAWARE • 19899

*HERCULES TRADEMARK

Besides greatly reducing the time and labor consumed in loading Hercosplit blast holes, it often is possible when using Hercosplit 1 or Hercosplit WR to widen the drill hole spacings appreciably, which in turn lowers the overall drilling cost.

HERCOSPLIT 40 AND HERCOSPLIT 40 WR

Hercosplit 40 and Hercosplit 40 WR are high explosives especially designed for ease of loading in Hercosplitting, that are available in 1¼ by 8-in. cartridges equipped with longitudinal paper tunnels. These tunnels enable the cartridges to be slid down the detonating fuse downlines (after the detonating fuse is lowered into the holes) in drill holes that are to be Hercosplit.



Normal method of using either Hercosplit 40 or Hercosplit 40 WR

[illegible]

Grade	Kind	Water Resistance	Fume Class	Nominal Number of Cartridges Per 50-Lb. Case*	Nominal Weight Per Cartridge In Pounds
Hercosplit 40, 1¼ x 8 in., equipped with tunnels	Ammonia Dynamite	Not recommended for use under water	1	108	0.463
Hercosplit 40 WR, 1¼ x 8 in., equipped with tunnels	Ammonia Gelatin	Detonates completely after 18 hours under 50 feet of water	1	94	0.532

*Subject to a variation of plus or minus 3% from the nominal cartridge count.

Extra 8-in.-long paper tunnels may be purchased separately to act as convenient separators (which may be cut into increments or used in whatever multiples are desired) between the individual cartridges placed in the drill holes. These tunnels are slid down on the detonating fuse downlines in the same manner as the cartridges. Loading speed is greatly enhanced by the use of these tunneled Hercosplitting explosives.

KARVITE®*

Although originally developed for perimeter, or "smooth," blasting in underground mining or construction projects, Karvite also finds application for Hercosplitting in formations where the rock is somewhat friable and weathered.

*For information concerning the use of Karvite for perimeter (or "smooth") blasting underground, please refer to the Hercules Explosives Technical Data Sheet entitled "Karvite Blasting."

PROPERTIES OF KARVITE

Grade	Kind	Water Resistance	Fume Class	Nominal Number of Cartridges Per 50-Lb. Case*	Nominal Weight Per Cartridge In Pounds
Karvite, 5/8 x 24 in.	High-Ammonium-Nitrate-Content Dynamite	Not recommended for use under water	1	175	0.286

*Subject to a variation of plus or minus 3% from the nominal cartridge count.

When used for Hercosplitting, the Karvite should be initiated with detonating fuse in the same manner as Hercosplit 1 and Hercosplit WR.

RX PRIMALINE

CORE	NOMINAL GRAINS PER FT.	OUTSIDE DIAMETER INCHES	MINIMUM TENSILE STRENGTH	SHIPPING WEIGHT 2,000 FEET 2-1000 ft. SPOOLS
PETN	15	.145 ± .005	275 lbs.	18 lbs.

DETACORD

CORE	NOMINAL GRAINS PER FT.	OUTSIDE DIAMETER INCHES	MINIMUM TENSILE STRENGTH	SHIPPING WEIGHT	
				1000 FT. PULL OUT BOX	2000 FT. 2-1000 ft SPOOLS
PETN	18	.150 ± .005	150 lbs.	8½ lbs.	17 lbs.

E-CORD

CORE	NOMINAL GRAINS PER FT.	OUTSIDE DIAMETER INCHES	MINIMUM TENSILE STRENGTH	SHIPPING WEIGHT	
				1000 FT. PULL OUT BOX	2000 FT. 2-1000 ft SPOOLS
PETN	25	.157 ± .005	150 lbs.	10½ lbs.	22 lbs.

STRIP MINE SPECIAL

CORE	NOMINAL GRAINS PER FT.	OUTSIDE DIAMETER INCHES	MINIMUM TENSILE STRENGTH	SHIPPING WEIGHT 2,000 FEET 2-1000 ft. SPOOLS
PETN	40	.190 ± .005	300 lbs.	27 lbs.

REINFORCED PRIMACORD

CORE	NOMINAL GRAINS PER FT.	OUTSIDE DIAMETER INCHES	MINIMUM TENSILE STRENGTH	SHIPPING WEIGHT 2,000 FEET 2-1000 ft. SPOOLS
PETN	50	.200 ± .008	200 lbs.	33 lbs.

Sales Offices

207 Pine Creek Road
Wexford, Pennsylvania 15090
(412) 935-5712

5011 Washington Avenue
Evansville, Indiana 47715
(812) 476-1329

2616 Old Wesley Chapel Rd.
Decatur, GA 30034
(404) 288-8497

Post Office Box 97
Louviers, Colorado 80131
(303) 798-8625

660 Hopmeadow Street
Simsbury, Connecticut 06070
(203) 658-4411

The Ensign-Bickford company
BLASTING PRODUCTS DIVISION
660 Hopmeadow St. Simsbury, Conn. 06070

[illegible]
Boosters or high-impulse, high-detonation [illegible]
Boosters are high-impulse, relatively insensitive, cast (nonnitroglycerin) explosives designed for detonating either blasting agents or desensitized explosives in conjunction with detonating cord, electric blasting caps, or nonelectric delay devices. Suggested application is as follows:

Borehole Diameter in.	mm	Recommended Type of Titan Booster	Recommended Nitroglycerin-Type Primers	It Is Recommended That Two Primers Be Used per Hole When the Powder Column Exceeds the Following Lengths[a]
2-2½	57-64	Titan Booster 150A	Gelatin Extra 60%, 1½ × 8 in., or Gelaprime®, 1½ × 8 in. (38 × 203 mm)	10 ft (3.05 m)
2½-3	64-76	Titan Booster 225A	Gelatin Extra 60%, 2 × 8 in., or Gelaprime, 2 × 8 in. (51 × 203 mm)	15 ft (4.6 m)
3-3½	76-89	Titan Booster 350A	Gelatin Extra 60%, 2½ × 16 in. (64 × 406 mm) or Gelaprime, 2 × 8 in. (51 × 203 mm)	20 ft (6.1 m)
3½-6	89-152	Titan Booster 500A Titan Booster 500MA	Titan G Booster, Gelatin Extra 60%, 3 × 24 in. (76 × 610 mm) or Gelaprime, 2 × 8 in. (51 × 203 mm)	25 ft (7.6 m)
6 in. (152 mm) and up		Titan Booster 2500A	Titan G Booster, Gelatin Extra 60%, 5 in. × 16⅔ lb, or Gelaprime, 5 in. × 16⅔ lbs (127 mm × 7.6 kg)	25 ft (7.6 m)

[a] When two boosters are necessary, place one near the bottom and one near the top of the main charge in the borehole. Additional boosters may be required if the blaster feels that separations or blockages may occur as the borehole is being loaded. It is imperative that each booster be threaded on the detonating cord downline or be individually primed with a detonator.

Packaging

Hercomix 1 blasting agent is furnished in 50-lb (22.7-kg) net polyethylene-lined, multiwall paper bags.

Transportation, Storage, and Handling

This blasting agent is not initiation-sensitive to No. 8 blasting caps or rifle bullets, and thus need not be stored in bullet-resistant magazines unless so required by relevant laws or regulations. Storage magazines should be located to conform to the American Table of Distances and the Table of Separation Distances of Ammonium Nitrate and Blasting Agents From Explosives or Blasting Agents.

Hercomix is classified by the U.S. Department of Transportation as Blasting Agent, and must be transported, stored, handled, and used in conformity with all applicable Federal, state, and local laws and regulations. The proper shipping description and hazard classification for Hercomix 1 as described in this bulletin is:

Ammonium Nitrate/Fuel Oil Mixture—Blasting Agent

This product should be kept dry, and stock should be rotated so that the oldest material is used first. Use only proper primers, and never load in wet holes or where there is not adequate confinement. If these restrictions are observed, the formation of toxic fumes will be minimized. This product, as manufactured, conforms to the Institute of Makers of Explosives Fume Class 1 rating.

For additional recommended good practices in transporting, storing, handling, and using this product, consult the Safety Library Publications of the Institute of Makers of Explosives.

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HERCULES

Hercules Incorporated
910 Market Street
Wilmington, DE 19899

Atlanta	Chicago	Denver	San Francisco, CA 94111	Wilmington, DE 19899
Norcross, GA 30071	Oak Brook, IL 60521	Englewood, CO 80111	One Maritime Plaza	300 Delaware Avenue
3169 Holcomb Bridge Road	814 Commerce Drive	5680 S. Syracuse Circle	Golden Gateway Center	16th Floor
Suite 700	Suite 302	Suite 414	Suite 1250	(302) 575-5700
(404) 447-9120	(312) 887-3000	(303) 779-1717	(415) 986-2535	

BULLETIN TD-203C
(Supersedes TD-203B)

HERCOMIX® 1 Blasting Agent

Description

HERCOMIX® 1 is a premixed, prilled ammonium nitrate/fuel oil-type, 65% weight-strength blasting agent[1] suitable for use under dry borehole conditions. It can be used for quarry, open-pit and construction, or underground blasting operations, and can be either blown into the borehole by pneumatic loading devices or poured.

This highly economical blasting agent has an average poured density of about 0.80 g/cm³, or 50 lbs/ft³. When holes are loaded pneumatically, average density is about 0.95 g/cm³, or 60 lbs/ft³.

Hercomix 1 blasting agent, as packed and when used under dry borehole conditions, will produce Class 1 fumes.

[1] Blasting agent: Any material or mixture consisting of a fuel and oxidizer, intended for blasting, not otherwise classified as an explosive, provided that the finished product, as mixed for use or shipment, cannot be detonated by means of a No. 8 test blasting cap when unconfined.

Typical Characteristics

Measured energy, ft-lbs/lb × 10^6 .... 1.10
Measured energy, ft-lbs/ft³ 54

APPROXIMATE LOADING DENSITY AND RATE OF DETONATION

Borehole Diameter, in.	mm	Approximate Weight per Foot of Borehole When Poured, lbs	kg	Approximate Detonation Velocity (confined), fps	mps
2	51	1.1	0.50	10,700	3,261
3	76	2.4	1.09	10,900	3,322
4	102	4.4	2.00	11,800	3,597
5	127	6.8	3.08	12,400	3,780
6	152	9.8	4.44	12,800	3,901
7	179	13.3	6.02	13,100	3,993
8	203	17.4	7.88	13,300	4,054
9	229	22.0	9.97	13,400	4,084
10	254	27.2	12.32	13,500	4,115
11	279	32.9	14.90	13,600	4,145
12	305	39.2	17.76	13,650	4,160
13	330	46.0	20.80	13,700	4,176
14	356	53.3	24.14	13,700	4,176
15	381	61.2	27.72	13,750	4,191
16	406	69.6	31.53	13,750	4,191
17	432	78.6	36.61	13,750	4,191
18	457	88.1	39.91	13,750	4,191

(over)

Packaging

Unigel semigelatin dynamite is available in the following cartridge sizes and counts:

PRODUCTION	Cartridge Size	Nominal Cartridge Count per 50-lb (22.6-kg) Case	Detonation Velocity (Confined) fps	mps
	1⅛ × 8 in. (28.6 × 203 mm)	134-142	13,700	4,175
	1¼ × 8 in. (31.8 × 203 mm)	109-115	14,300	4,360
	1½ × 8 in. (38 × 203 mm)	76-82	15,400	4,700
DRY HOLE →	2 × 8 in. (51 × 203 mm)	41-45	16,100	4,900
	2 × 16 in. (51 mm × 41 cm)	19-22	16,100	4,900
	2¼ × 16 in. (57 mm × 41 cm)	16-18	16,700	5,090
WET HOLE →	2½ × 16 in. (64 mm × 41 cm)	13-14	16,700	5,090
	2¾ × 16 in. (70 mm × 41 cm)	12-13	16,700	5,090
	3 × 16 in. (76 mm × 41 cm)	10	16,900	5,151
	3½ × 16 in. (89 mm × 41 cm)	7	16,900	5,151
	4 × 16 in. (102 mm × 41 cm)	6	17,000	5,182
	4½ × 16⅔ lbs (114 mm × 7.5 kg)	3	17,000	5,182
	5 × 25 lbs (127 mm × 11.3 kg)	2	17,200	5,243

Transportation, Storage, and Handling

The proper shipping description and hazard classification for Unigel as described in this bulletin is:

High Explosives—Class A—Explosive—(Dynamite)

For recommended good practices in transporting, storing, handling, and using this product, see "Do's and Don'ts" Instructions and Warnings packed inside each case, and consult the Safety Library Publications of the Institute of Makers of Explosives.

Stock should be rotated. Avoid using new material before old.

Unigel is classified by the U.S. Department of Transportation as High Explosive Class A and must be transported, stored, handled, and used in conformity with all applicable Federal, state, and local laws and regulations.

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HERCULES

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910 Market Street
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3169 Holcomb Bridge Road
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(404) 447-9120

Chicago
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(312) 961-4000

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San Francisco
Walnut Creek, CA 94596
590 Ygnacio Valley Road
Suite 300
(415) 930-3500

Wilmington, DE 19899
300 Delaware Avenue
16th Floor
(302) 575-5700

BULLETIN TD-213I
(Supersedes TD-213H)

UNIGEL® Semigelatin Dynamite

Description

Unigel® is a specially formulated semigelatin dynamite developed exclusively to be a single, all-purpose explosive grade that can be used for most blasting applications, with resultant savings in explosive costs. It is a replacement for many of the more expensive specialty-grade dynamites that offer varying energy value with each grade.

Unigel has good water resistance and excellent uniformity of mixture and plasticity, withstands long periods of storage without deterioration, and will detonate completely under moderate water pressure. Unigel is an excellent primer for ANFO.

Typical Characteristics

Specific gravity	1.27
Weight strength, %	66
Cartridge strength, %	58
Minimum sensitiveness, in. (mm)	12 (305)[a]
Detonation (confined) velocity, fps (mps)	14,300 (4,360)[a]
Measured energy × 10^6:	
Weight, ft-lbs/lb	.95
Volume, ft-lbs/ft³	75
Energy comparison (with ANFO as 100)	
Weight	86
Volume	143
Fumes	Class 1[b]
Water resistance (2-in.-dia. (51-mm) cartridge)	Will detonate after 24 hrs under 12 ft (3.66 m) of water
Shelf life	One year under cool, dry, and well-ventilated storage conditions

[a] 1¼-in. (32-mm) diameter.
[b] 2-in.-diameter cartridge and above will be Fume Class 1 unless requested Class 2

Features

- Single explosive grade for universal blasting applications—simplified inventory requirements.
- Minimum afterblast fumes and smoke.
- Extremely good shelf life—superior to most gelatin extra dynamites.
- Unigel semigelatin dynamite can be used as the main explosive charge or as a primer for ANFO mixtures because of its high rate of detonation.
- Provides performance equivalent to that of more costly specialty grades at less cost.

(over)

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Technical Information

BULLETIN TD-204C
(Supersedes TD-204B)

HERCULES® PERMISSIBLE EXPLOSIVES

Description

Hercules permissible explosives[1] are designed to meet or exceed any coal mine blasting requirement encountered, including underground coal construction. They are available in three nonnitroglycerin brands and eight nitroglycerin-sensitized brands. Each has been custom-developed for a particular use and then adapted especially for that use after years of fieldwork that included both explosives grade elimination and optimization studies. The result is a compact list of improved and easy-to-select-from group of permissible explosives that will provide both economy and efficiency in any coal-blasting operation.

[1] Explosives that have been tested by the Mine Safety & Health Administration and passed as safe for blasting in gaseous and dusty coal mines if used in accordance with the Code of Federal Regulations (30 CFR 15.19).

Typical Characteristics

Brand	Measured Energy × 10⁶ Weight, ft-lbs/lb	Measured Energy × 10⁶ Volume, ft-lbs/ft³	Average Detonation Velocity in 1¼ × 8-in. Cartridges ft/sec	Average Detonation Velocity in 1¼ × 8-in. Cartridges m/sec	Water Resistance[b]	Minimum Permissible Cartridge Dia, in.[c]	Fume Class, Bureau of Mines	Nominal Cartridge Count per 50-lb Case, 1¼ × 8-in. dia
Nonnitroglycerin Permissibles[a]								
Hercoal™ 330	0.92	69	9,840	3,000	3½	1	A	117-124
Hercoal 340	0.88	54	9,510	2,900	3½	1	A	142-150
Hercoal 378	1.04	79	11,800	3,300	2	1	A	114-122
Nitroglycerin-Sensitized Permissibles								
Red H® A	0.95	63	8,200	2,500	3	1	A	116-124
Red H C	0.95	61	5,400	1,650	3½	1	A	135-145
Red H F	0.95	49	6,400	1,950	3½	1	A	173-185
Red H L	0.96	49	6,250	1,900	4	1	A	184-196
Collier® C	0.90	52	9,900	3,025	3	1	A	155-165
Red H B	1.00	63	10,400	3,175	3	1	A	135-145
Hercogel® A	0.95	89	16,900	5,150	2	1	A	96-104
Hercogel B	0.95	89	16,500	5,030	2	1⅛	A[d]	96-104

[a] When compared with nitroglycerin-sensitized permissibles, the outstanding features of nonnitroglycerin permissibles are (1) they do not produce headaches after handling and (2) they produce improved afterblast smoke.
[b] Rating ranges from 1 to 4, with 1 the best.
[c] According to Mine Safety & Health Administration (MSHA) regulations.
[d] All Hercules permissible explosives are in the U.S. Department of Interior's Bureau of Mines (USBM) Fume Class A. Only Hercogel B is formulated to be in both USBM Fume Class A and IME Fume Class 1.

Selection of Permissibles

Of the factors that enter into the choice of a permissible explosive for a given application, probably the two most important are (1) detonation velocity and (2) energy. A permissible with a slow detonation velocity will usually produce a higher percentage of prepared coal sizes, while a fast permissible has the smashing action desired in the production of fine sizes such as coking coal. To assist in selection of the brand that is most suitably adapted for a particular application, Hercules offers the following:

(over)

Application	Brand(s) Recommended	Features
Production of prepared sizes of coal under light water conditions.	Red H C Red H F Red H L	Each of these brands offers as slow a detonation velocity as possible, while still maintaining sensitiveness. Collectively, they offer a wide and comprehensive range of strength and cartridge count.
For coal seams that contain rock binders and are difficult to shoot. These brands are adaptable for use under moderate water conditions.	Red H A Red H B Collier C Hercoal 330 Hercoal 340	These brands provide a moderately high rate of detonation, and are excellent products for shooting coal "off-the-solid."
For rock blasting as done in underground coal construction work. This product is adaptable for use in moderate to heavy water conditions.	Hercoal 378	This product is especially designed for use where nonheadache-producing handling and improved afterblast fumes are factors in the use of permissibles.
For use in coal seams where very hard rock is encountered and where water conditions are severe.	Hercogel A	Recommended for use where it is not practical to use a more economical, but weaker and less water-resistant permissible.
For use in underground coal construction such as hard rock blasting for shafts, slopes, entries, and overcasts.	Hercogel B	Because of its fume class (satisfying both Bureau of Mines Class A and IME Class 1) and high-velocity and energy characteristics, this product grade is the ideal selection for uses where all regulations for permissibility must be observed.
NOTE: All Hercules permissible explosives contain a high percentage of granulated salt to make them even more preferable for coal mining. The salt has a cooling effect on the flame emitted by detonation of the permissibles, and reduces the chance of the explosives igniting gas or coal dust. Even though these high-salt permissibles provide an added factor of safety to coal mine blasting, they must be used in full compliance with all permissible regulations.		

Packaging

All Hercules permissible explosives except Hercogel A and Hercogel B are available in all standard cartridge sizes of 1 to 2-in. diameter and 8-in. length, and in king-size cartridges[2] of 1¼ to 2-in. diameter and lengths of 12, 16, 20, and 24 in.

Hercogel A is available only in standard cartridge sizes of 1 to 2-in. diameter and 8-in. length. It is not available in king-size cartridges.

Hercogel B is available only in standard cartridge sizes of 1⅛ to 1¾-in. diameter and 8-in. length. No other sizes are available.

[2] King-size permissible cartridges provide a more continuous column (fewer cartridge crimps), which results in more efficient detonation and a reduction in afterblast fumes and smoke. Opportunity for a fixed charge is possible. This improves the explosives economy, for there is less waste in part-cartridges and more time saved in loading the boreholes. Furthermore, there is considerably less chance for misfires from coal dust collecting between cartridges.

Storage

Permissible explosives, particularly the grades with low strength and low velocity, absorb moisture readily and may deteriorate as a result. For this reason, the oldest stock should be used first in order to minimize duration of storage. Once permissibles are taken underground, they should be used within 48 hrs, as specified in the U.S. Bureau of Mines permissibility regulations.

The products described in this technical data sheet are classified as High Explosives and must be transported, stored, handled, and used in conformity with all applicable Federal, state, and local laws and regulations.

2-83

HERCULES

Hercules Incorporated
910 Market Street
Wilmington, DE 19899

Atlanta
Norcross, GA 30071
3169 Holcomb Bridge Road
Suite 700
(404) 447-9120

Chicago
Naperville, IL 60566
One Energy Center
300 East Shuman Boulevard
Suite 260
(312) 961-4000

Englewood, CO 80111
6484 South Quebec Street
(303) 779-1717

San Francisco
Walnut Creek, CA 94596
590 Ygnacio Valley Road
Suite 300
(415) 930-3500

Wilmington, DE 19899
300 Delaware Avenue
16th Floor
(302) 575-5700

COMPUTATION SHEET	DATE
	PAGE OF PAGES

SUBJECT
BLAST VIBRATION MONITORING

COMPUTATION
SEISMOGRAPHIC REPORTS

NO.

COMPUTED BY

CHECKED BY

1	Mono. 7, 8, 9	3-27-84	P/S		86' Due N	0.08	
2	Mono. 9	3-30-84	Prod.		86' Due N	0.05	
3	Mono. 8	3-30-84	Prod.		86' Due N	0.05	
4	Mono. 6, 7	4-02-84	Prod.		86' Due N	0.07	
5	Mono. 6	4-03-84	Prod.		86' Due N	1.00	
6	Mono. 2, 3	4-10-84	P/S		225' NE	0.02	
7	Mono. 2, 3	4-10-84	Prod.	Access Rd.	400' S	0.04	
8	Mono. 2	4-12-84	Prod.	Access Rd.	325' S	0.01	
9	Mono. 10	3-05-85	P/S		40' SW	0.02	
10	Mono. 14	3-07-85	Prod.		175' SW	0.02	
11	Mono. 11, 12	3-13-85	Prod.		85' SW	0.04	
12	Mono. 10, 11	3-13-85	Prod.		25' SW	0.03	
13	Mono. 10, 11	3-14-85	Prod.		25' SW	0.02	

ORH FORM 7 DEC 44 437

VIBRA-TEC'' ENGINEERS BLAST AND SEISMOGP ?HIC REPORT

BLAST DATA

Client US Army Corps of Engineers

Job Location Stonewall Jackson Lake Dam

Date 12 April 1984 Blast No. 8 Time 3:55 pm

Exact Blast Location Monolith #2 Production shot

No. of Holes 92 Diameter 2½ in. Avg. Depth 1.25 ft. Subgrade ______ ft.

Spacing 2' x 2' ft. Burden ______ ft. Avg. Stemming 1' ft.

Make & Type of Explosives:		Delay Make	Miladet
Unigel	40 lbs.	Delay Type & Nos.	Hercules 450
	lbs.	Min. delay period	ms.
	lbs.	Max. lbs./delay period	5 lbs.
	lbs.	Blaster	William Young
	lbs.	Weather	cloudy
Total Explosives	40 lbs.	Wind Direction & Speed	1-2 mph SE direction

SEISMOGRAPH DATA

Seismograph No. GMS4 1090 Range/Gain Setting ______ ips

Everlert Only Trigger Level ______ ips

Exact Seismograph Location On access road to Monolith #3 325' south of Monolith #3 upstream

Seismograph Distance & Direction from Blast 325' south of Monolith #3 SW from blasting

Meters
- Peak Overpressure 120.1 dB
- Peak Particle Velocity 0.01 ips

Operator E. Mendenilla

Cassette No. I

Remarks:

Vibration Analysis by: ______ Date: ______

Vibra-Tech Engineers, Inc.

(USE REVERSE SIDE FOR BLAST DIAGRAM)

1 2 3 4 5 6

VIBRA-TECH ENGINEERS INCORPORATED

706 ROCKVILLE PIKE • ROCKVILLE, MARYLAND 20852

301-762-8175

CONSULTANTS TO THE MINING, QUARRYING, CONSTRUCTION AND EXPLOSIVE USING INDUSTRIES.

VIBRA-TAPE® GMS 4

the sophisticated one

VIBRA-TAPE PROVIDES FOR SOPHISTICATED RECORDING OF GROUND AND AIR EFFECTS FROM BLASTING IN TERMS OF PARTICLE VELOCITY & DECIBELS

The Vibra-Tape GMS-4 Blasting Seismograph is a four channel instrumentation cassette tape recording system (record only) designed for field recording of three channels of seismic data and one channel of air overpressure signals while simultaneously presenting a visual display of the peak velocity sensed by any of the three component velocity sensors (pickups), and the air-concussion sensed by the microphone. It is intended for use by blasters, contractors or quarry operators in conjunction with professional persons rendering consulting services in blast damage control. The full signature of the earthborne vibration and the air overpressure signals are recorded on magnetic tape for subsequent reproduction on auxiliary equipment and detailed analysis.

The Vibra-Tape GMS-4 has an easy to use, operating sequence which assures the user of obtaining quality data after only a few minutes of instruction. Data recorded on the tape includes the three velocity components of earth motion (one vertical, two horizontal), air or sound pressure in decibels and lbs. per sq. inch, dynamic calibration data for the velocity pickup, battery voltage, tape calibration data, and voice comments for event identification and notations of the meter's reading.

The instrument's meter indicates and holds the peak velocity sensed by any of the three pickups and the air blast sensed by the microphone until the reading is noted and reset or the instrument is turned off by the operator. The standard meter reads directly in inches per second of peak velocity and decibels of peak air-concussion and allows the operator to know immediately the level of vibration and air-borne effects that have been recorded. This enables the blaster to adjust, and thus control, his shooting to stay within desired limits.

Standard seismic frequency response of the Vibra-Tape GMS-4 is 1 to 200 Hz or higher (3dB points). The velocity pickups have a 10 Hertz natural frequency with special amplifiers to achieve the 1.0 Hz response. The pickups are rugged in construction and are easily employed. The acoustic microphone has a built-in preamplifier which minimizes stray electrical signals and line noise. Storage is provided for the three component pickup, the pressure microphone and the internal batteries. The instrument's standard 6 volt lantern batteries provide up to 75 hours of operation, whereas each shot normally should not require more than five minutes to record. The recommended C60SD cassette tapes can record continously up to 30 minutes.

7.21.4 (...)

301-762-8175

vibra-tech engineers incorporated

CONSULTANTS TO THE MINING, QUARRYING, CONSTRUCTION AND EXPLOSIVE USING INDUSTRIES

706 ROCKVILLE PIKE ROCKVILLE, MD 20852

June 7, 1983

Mr. Otto Feuer
Wiley N. Jackson Company
P.O. Box 4195
Roanoke, Virginia 24015

VIBRA-TAPE GMS 4 #1090

Dear Mr. Feuer,

This letter is to confirm that a period of instruction on the correct operation and use of the Vibra-Tape GMS 4 seismograph was provided by Mr. Dale R. Houck on June 2, 1982, at your Roanoke office.

The following people were present for that instruction:

1. James Silvers
2. Karen Silvers
3. Clayton Smart
4. Andy Clark
5. Otto Feuer
6. Lynn Gisiner

If anyone has any questions or requires additional information please do not hesitate to contact this office at any time.

Yours faithfully,

VIBRA-TECH ENGINEERS, INC.

G. A. Foster

G. Alan Foster
Sr. Vice President

CERTIFICATE OF CALIBRATION

VIBRA-TECH ENGINEERS, INC.

This is to certify that Vibra-Tape® Analog Blast Monitor, Serial Number GMS4-1090, has been dynamically calibrated by Vibra-Tech Engineers, Inc. on May 12, 1983, with the following calibration references traceable to the National Bureau of Standards.

1) Dallas Instrument's Shake Table
Model ST-3T, Serial No. 7709-4

2) Quest Electronics Sound Level Calibrator
Model CA-12, Serial No. U0091000

Any necessary re-calibration procedures were conducted in accordance with the manufacturer's specifications.

Calibrated By: Douglas G. Bartley

Witnessed By: Sharian L. Hadricky

Date: 5/12/83

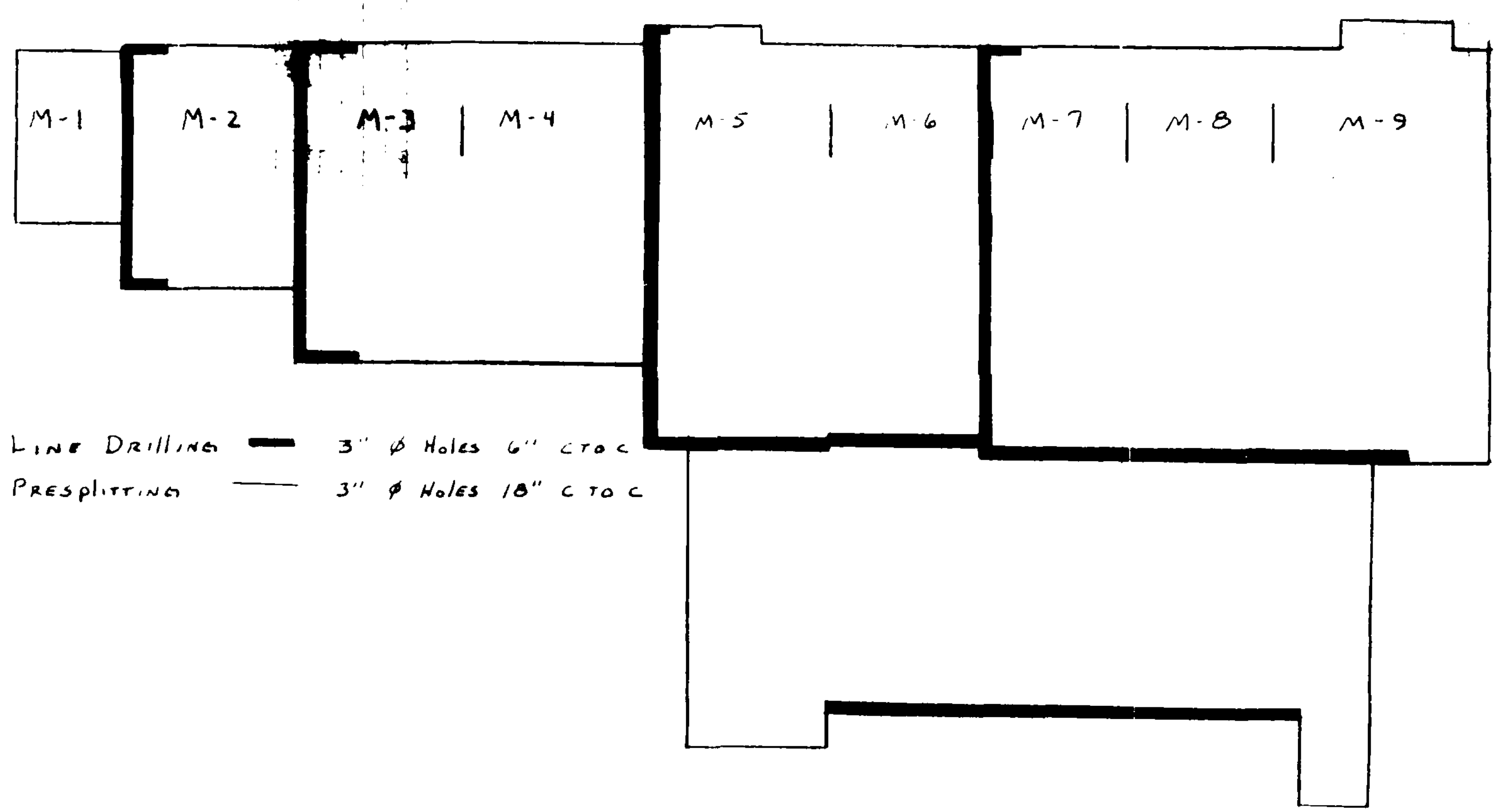
SHARIAN L. HADRICKY, NOTARY PUBLIC
McCANDLESS TWP., ALLEGHENY COUNTY
MY COMMISSION EXPIRES JAN. 28, 1985
Member, Pennsylvania Association of Notaries

10-01

"M"

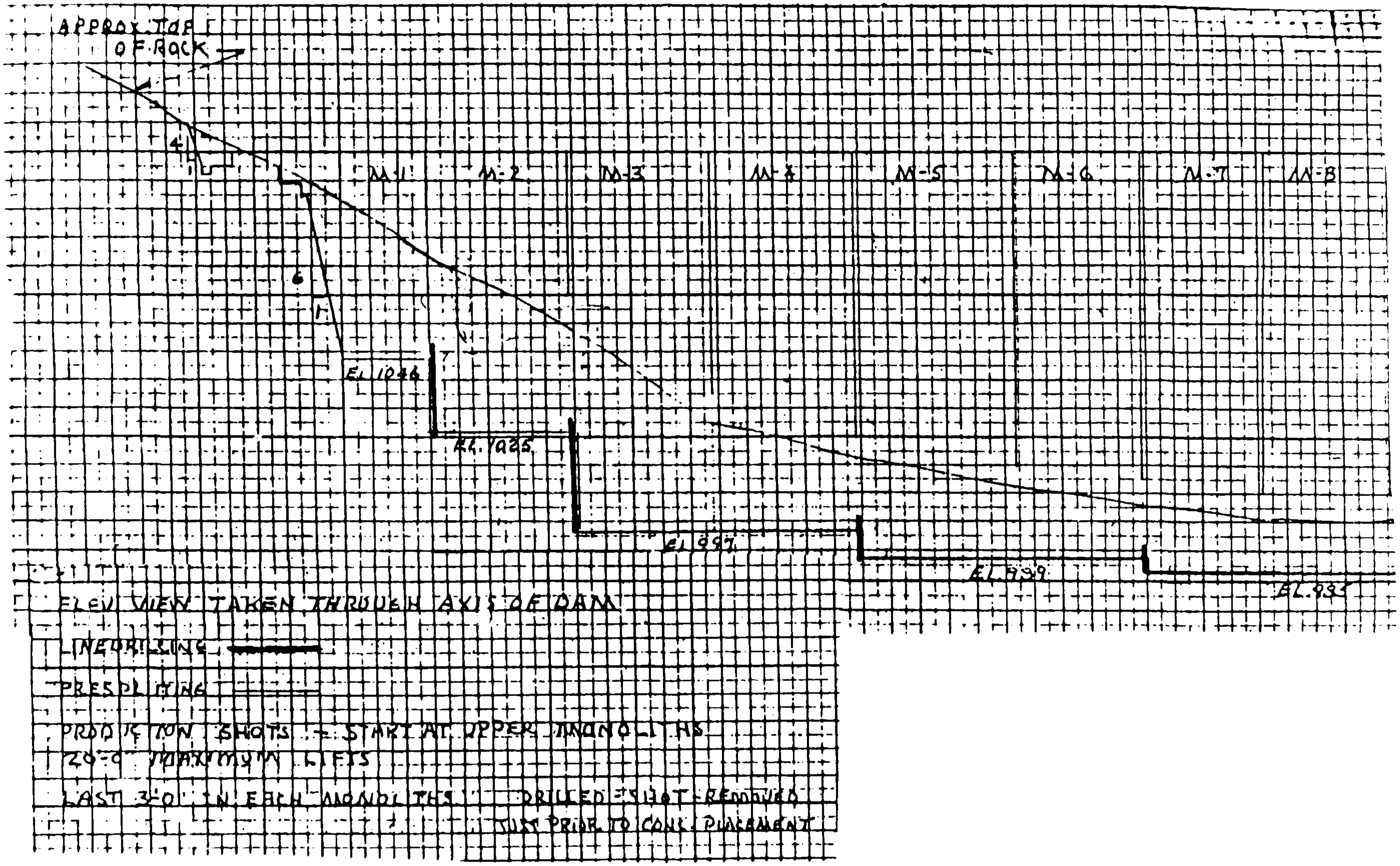
LINE DRILLING

LINEDRILLING
(Partial)



PLAN VIEW

Scale 1" = 40'


APPROX TOP OF ROCK
M-1
M-2
M-3
M-4
M-5
M-6
M-7
M-8
EL 1046
EL 1025
EL 997
EL 959
EL 935
ELEV VIEW TAKEN THROUGH AXIS OF DAM
LINEDRILLING
PRESPLITTING
PRODUCTION SHOTS - START AT UPPER MONOLITHS
20'-0" MAXIMUM LIFTS
LAST 3'-0" IN EACH MONOLITHS DRILLED - SHOT - REMOVED JUST PRIOR TO CONC. PLACEMENT

10-01

"N"

DRAINAGE GALLERY DRAINS

COMPUTATION SHEET	DATE PAGE OF PAGES

SUBJECT DRAINAGE GALLERY DRAIN HOLES - Nipple Depth 1.75'

COMPUTATION | NO.

COMPUTED BY | CHECKED BY

NO	STA - LOCATION	MON	ELEV T/CONC	ELEV T/RO	< DEP	ELEV B. HOLE	< TOTAL DEPTH
1	1+27.50	1	1051.25	1045	6.3	998.5	53.6
2	1+30.00	1	1051.25	1045	6.3	994.0	58.1
3	1+42.50	1	1051.25	1045	6.3	984.5	68.3
4	1+52.50	2	1047.50	1022	25.9	977.0	71.6
5	1+62.50	2	1040.00	1022	18.3	970.0	71.1
6	1+72.50	2	1035.00	1022	13.2	964.0	72.1
7	1+82.50	2	1030	1022	8.1	957.0	74.1
8	1+95.00	3	1005.00	995.6	9.5	954.5	51.3
9	2+02.50	3	1005.00	995.6	9.5	954.0	51.8
10	2+12.50	3	1005.0	995.6	9.5	953.0	52.8
11	2+22.50	3	1002.50	995.6	7.0	952.0	51.3
12	2+32.50	4	1002.50	995.6	7.0	951.00	52.3
13	2+42.50	4	1002.50	995.6	7.0	950.0	53.3
14	2+52.50	4	1002.50	995.6	7.0	949.0	54.3
15	2+62.50	4	1002.50	995.6	7.0	948.0	55.3
16	2+72.50	5	998.1	987.4	10.9	947.0	51.9
17	2+82.50	5	995.0	987.4	7.7	946.8	48.9
18	2+92.50	5	995.0	987.4	7.7	946.5	49.2
19	3+02.50	5	995.0	987.4	7.7	946.3	49.4
20	3+12.50	6	995.00	987.4	7.7	946.0	49.7
21	3+22.50	6	995.0	987.4	7.7	945.8	49.9
22	3+32.50	6	995.0	987.4	7.7	945.4	50.4
23	3+42.50	6	995.0	987.4	7.7	945.0	50.8
24	3+52.50	7	995.0	985.0	10.1	945.0	50.8

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7 DEC 44

COMPUTATION SHEET	DATE PAGE OF PAGES

SUBJECT DRAINAGE GALLERY DRAIN HOLES - Nipple Depth 1.75'

COMPUTATION | NO.

COMPUTED BY | CHECKED BY

NO	STA - LOCATION	MON	ELEV T/CONC	ELEV T/RO	∠ DEP	ELEV B. HOLE	∠ TOTAL DEPTH
25	3+62.50	7	995.0	985.0	10.1	945.0	50.8
26	3+72.50	7	995.0	985.0	10.1	945.0	50.8
27	3+82.50	8	995.00	985.0	10.1	945.0	50.8
28	3+92.50	8	995.0	985.0	10.1	945.0	50.8
29	4+00.00	8	995.0	985.0	10.1	945.0	50.8
30	4+12.50	8	995.0	985.0	10.1	945.0	50.8
31	4+22.50	9	995.0	985.0	10.1	945.0	50.8
32	4+32.50	9	995.0	985.0	10.1	945.0	50.8
33	4+42.50	9	995.0	985.0	10.1	945.0	50.8
34	4+52.50	9	995.0	985.0	10.1	945.0	50.8
35	4+62.50	10	995.0	985.0	10.1	945.0	50.8
36	4+72.50	10	995.0	985.0	10.1	945.0	50.8
37	4+82.50	10	995.0	985.0	10.1	945.0	50.8
38	4+92.50	10	995.0	985.0	10.1	945.0	50.8
39	5+02.50	11	995.0	985.0	10.1	945.0	50.8
40	5+12.50	11	1001.25	985.0	16.5	945.0	57.1
41	5+22.50	11	1005.00	985.0	20.3	945.0	60.9
42	5+32.50	11	1005.00	985.0	20.3	945.0	60.9
43	5+42.50	12	1005.00	985.0	20.3	945.0	60.9
44	5+52.50	12	1005.00	985.0	20.3	945.0	60.9
45	5+62.50	12	1005.00	985.0	20.3	945.0	60.9
46	5+72.50	12	1010.62	985.0	26.0	945.0	66.6
47	5+82.50	13	1015.00	1000	15.2	946.0	70.1
48	5+92.50	13	1019.37	1000	19.7	950.0	70.4

COMPUTATION SHEET	DATE
	PAGE OF PAGES

SUBJECT
DRAINAGE GALLERY DRAIN HOLES - Nipple Depth 1.75'

COMPUTATION | NO.

COMPUTED BY | CHECKED BY

NO	STA - LOCATION	MON	ELEV T/CONC	ELEV T/RO	∠ DEP	ELEV B. HOLE	∠ TOTAL DEPTH
49	6+02.50	13	1025.00	1000	25.4	953.5	72.6
50	6+12.50	13	1030.62	1000	31.1	957.5	74.2
51	6+22.50	14	1035.00	1027	8.1	962.0	74.1
52	6+32.50	14	1035.00	1027	8.1	967.8	68.2
53	6+42.50	14	1040.00	1207	13.2	975.5	65.5
54	6+52.50	14	1045.62	1027	18.9	982.0	64.6
55	6+62.50	15	1050.00	1040	10.1	988.0	62.9
56	6+72.50	15	1050.00	1040	10.1	991.0	59.9
57	6+82.50	15	1056.25	1040	16.5	994.5	62.7
58	6+92.50	15	1060.83	1040	21.1	998.0	62.8
59	7+02.50	16	1065.0	1060	5.1	1001.1	65.0
60	7+12.50	16	1065.0	1060	5.1	1006.0	59.9
61	7+22.50	16	1065.0	1060	5.1	1011.5	54.3
62	7+32.50	16	1065.0	1060	5.1	1016.5	49.2

ORH FORM 437
7 DEC 44

10-01

"O"

INSTRUMENTATION

SUBJECT PAGE

(1) Uplift Pressure Cells..............................O- 2 - O-10

(2) Horizontal and Vertical Controls..................O-11 - O-15

"O-1"

INSTRUMENTATION

(1) Uplift Pressure Cells

J.F. ALLEN COMPANY AND
WILEY N. JACKSON COMPANY, JOINT VENTURE
P.O. DRAWER 747
WESTON, WV 26452

25 June 1984

Army Corps of Engineers
P. O. Box 608
Weston, WV 26452

ATTENTION: Mr. William F. Woodburn
Resident Engineer

RE: Stonewall Jackson Lake Dam
DACW59-83-C-0053
West Fork River
UPLIFT PRESSURE CELLS -
INSTALLATION PROCEDURE

Gentlemen,

The eighteen (18) uplift pressure cells in Monoliths 5, 8 and 12 will be staked out and installed according to specified locations which are shown on contract drawing #037D-U1-88/2. A 4" diameter hole will be drilled 4 feet below the existing foundation elevation and thoroughly flushed with water. The 2'-6" x 1'-4" wooden box constructed of 3/4" material will be placed on the foundation with the bottom shaped to conform with the contour of the foundation and having a minimum depth of 8" at the highest point of rock. The schedule 120 PVC pipe tee, the two slotted schedule 80 PVC pipe with caps and the 1½" to 1" reducer will be installed in drilled hole and box. A short length of schedule 120 PVC pipe will then be installed through a pre-drilled hole in the wooden box and connected to the 1½" to 1" reducer. The 4" drilled hole and wooden box will then be filled with washed #8 pea gravel, the lid of the box will be attached and the box will be encased with a minimum of 6 inches of concrete at least 24 hours prior to placement of subsequent lift of concrete. The pipe runs will be placed with an upward slope of ¼" per foot form the cell to a point directly beneath the reading station and thence vertically upward to the gallery recess. The pipe assemblies will be held in position and secured during concrete placement.

THE READOUT STATION

The extended PVC uplift pipes exiting into the readout station will be protected with corrosion-resisting steel pipe. The end of each uplift pipe at the reading station will be capped with a shut-off cock and a snap-lock connector. A metal identification marker will be permanently fastened to each uplift pipe extending into the gallery recess.

We are enclosing copies of submittals #8, dated January 10, 1984 and #57, dated April 17, 1984 which have been approved for use on this project. The items listed were:

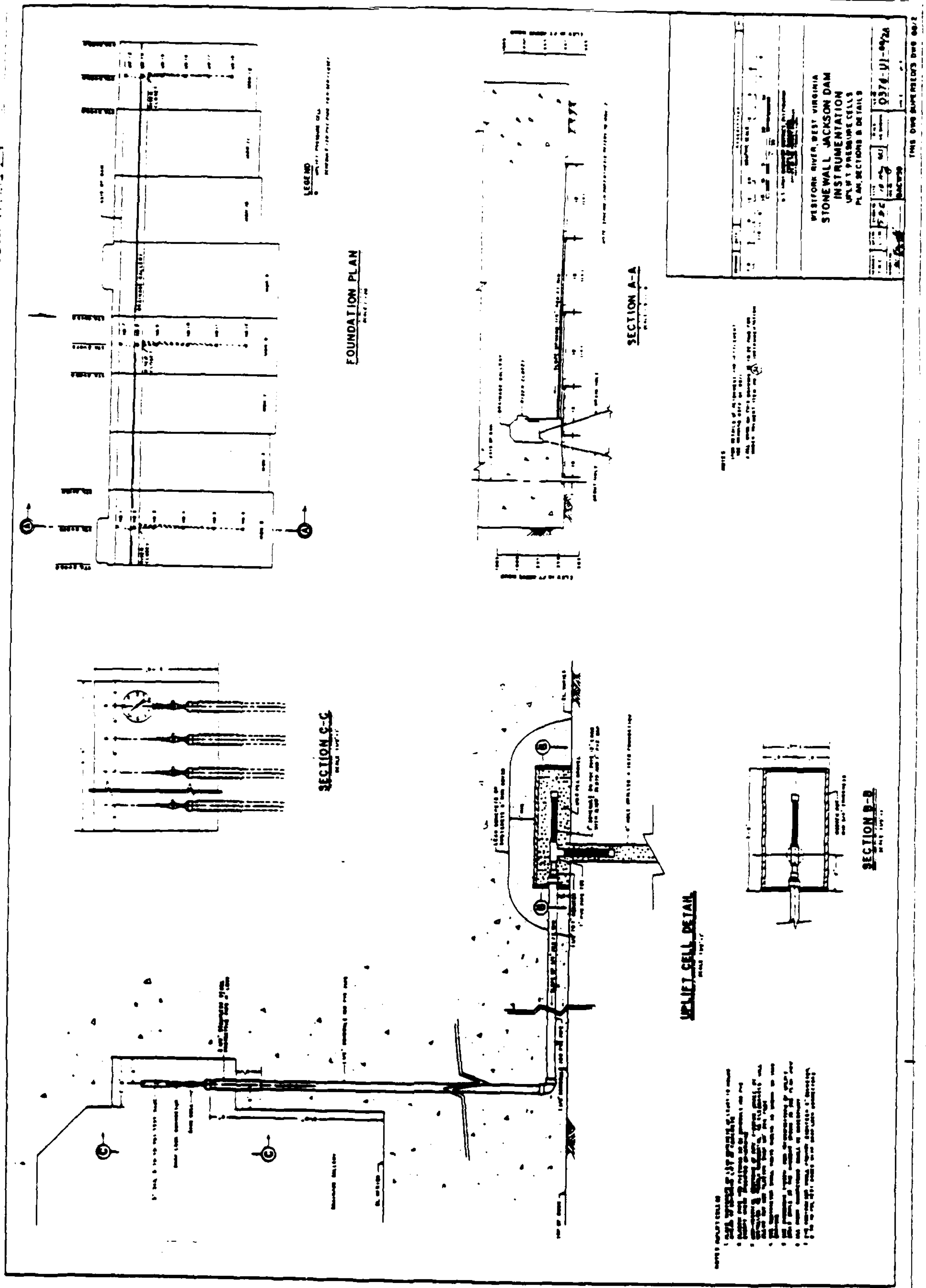
- 18 each - Parker ¼ brass couplers
- 18 each - Parker ¼ brass nipples
- 18 each - 6' diameter test gauge
- 18 each - 3/4" brass gauge cock

If there are additional questions concerning this matter, please do not hesitate to contact this office.

Respectfully yours,

E. Mendenilla
Field Engineer

EM/sh
cc: file
enc: as noted


FOUNDATION PLAN
SECTION A-A
SECTION C-C
UPLIFT CELL DETAIL
SECTION B-B
LEGEND
WESTFORK RIVER, WEST VIRGINIA
STONEWALL JACKSON DAM
INSTRUMENTATION
UPLIFT PRESSURE CELLS
PLAN, SECTIONS & DETAILS

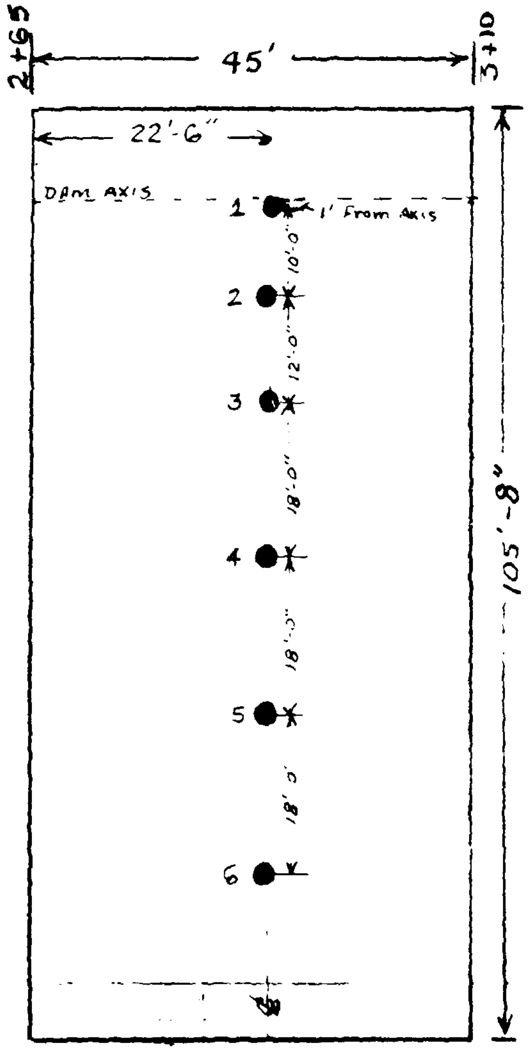
30 July 1986

STONEWALL JACKSON DAM

UPLIFT PRESSURE CELL LOCATIONS

Cell No.	Monolith No.	Dam Station	Axis Offset Downstream	Call Elev.	Gauge Elev.
1	5	2+87.5	1'	987.3	1000
2	5	2+87.5	11'	987.1	1000
3	5	2+87.5	23'	986.1	1000
4	5	2+87.5	41'	986.4	1000
5	5	2+87.5	59'	986.1	1000
6	5	2+87.5	77'	985.6	1000
7	8	3+97.5	1'	983.8	1000
8	8	3+97.5	11'	981.7	1000
9	8	3+97.5	23'	982.4	1000
10	8	3+97.5	41'	983.7	1000
11	8	3+97.5	59'	983.4	1000
12	8	3+97.5	77'	983.8	1000
13	12	5+58.0	1'	984.0	1010
14	12	5+66.25	12.8'	985.0	1010
15	12	5+58.0	16.0'	984.9	1010
16	12	5+58.0	39.0'	983.5	1010
17	12	5+58.0	53.0'	984.6	1010
18	12	5+58.0	67.0'	983.6	1010

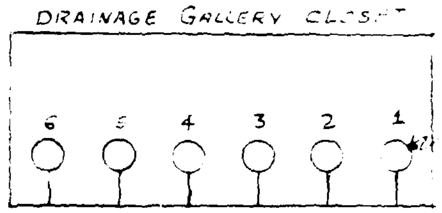
CORPS OF ENGINEERS, U.S. ARMY OHIO RIVER DIVISION	COMPUTATION SHEET	PAGE OF PAGES
INSTALLATION	SUBJECT Instrumentation – Uplift pressure cells	DATE
COMPUTED BY	COMPUTATION Monolith 5 : Sta 2+65 to 3+10	NUMBER M-5
CHECKED BY		



PLAN VIEW
(found. elev. 987.4)

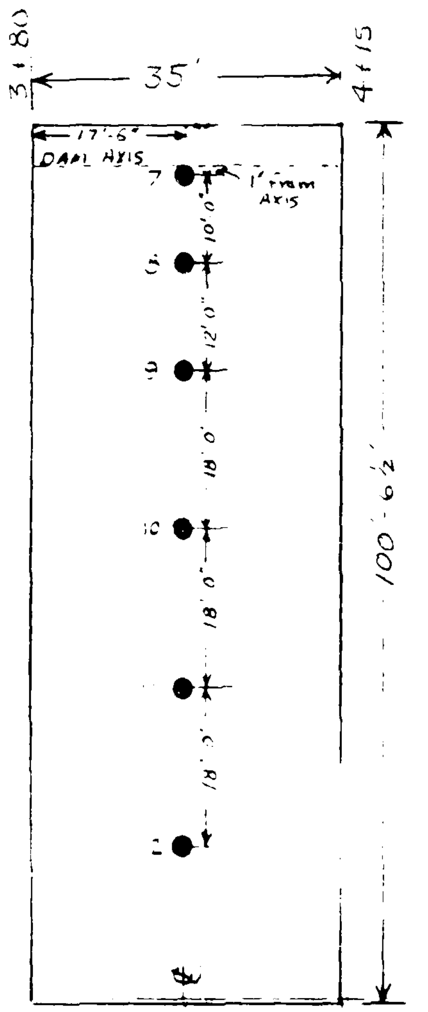
UPLIFT CELL ELEV.

1 -	987.3 ±
2 -	987.1 ±
3 -	986.1 ±
4 -	986.4 ±
5 -	986.1 ±
6 -	985.6 ±



GAGES ELEV. = 1000

CORPS OF ENGINEERS, U.S. ARMY OHIO RIVER DIVISION	COMPUTATION SHEET	PAGE OF PAGES
		DATE
INSTALLATION	SUBJECT Instrumentation - Uplift pressure Cells	
COMPUTED BY	COMPUTATION Monolith 8; Sta 3+80 - 4+15	NUMBER M-8
CHECKED BY		

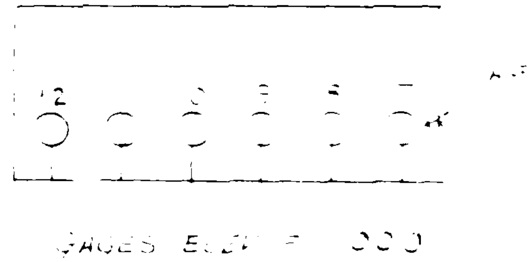


PLAN VIEW
(Found. elev. 985.0)

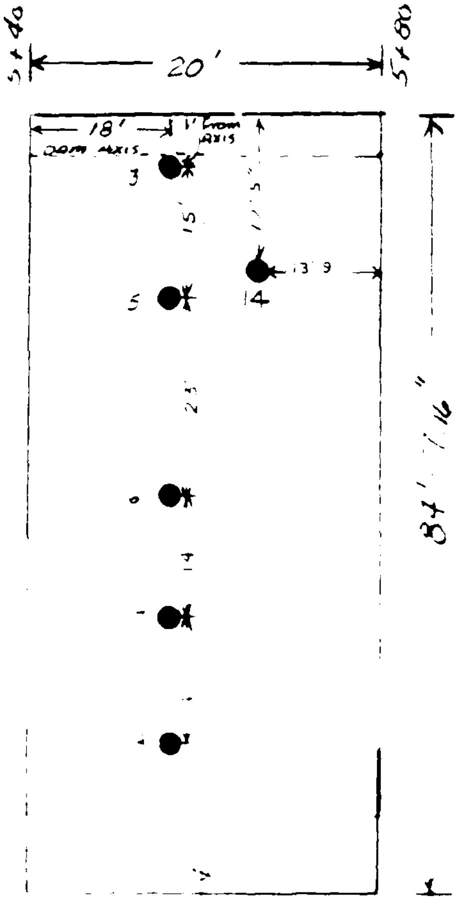
UPLIFT CELL ELEV.

7. -	983.8 ±
8. -	981.7 ±
9. -	982.4 ±
10 -	983.7 ±
11. -	983.4 ±
12 -	983.8 ±

DRAINAGE GALLERY CLOSET

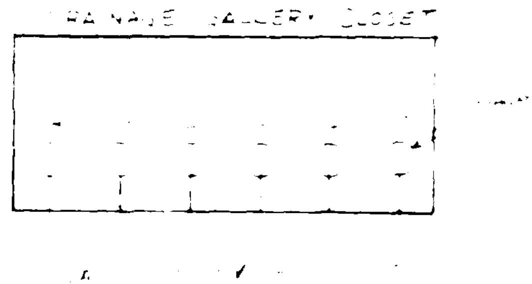


CORPS OF ENGINEERS, U.S. ARMY OHIO RIVER DIVISION	COMPUTATION SHEET	PAGE OF PAGES DATE
INSTALLATION	SUBJECT INSTRUMENTATION - Uplift Pressure Cells	
COMPUTED BY CHECKED BY	COMPUTATION Monolith 12, Sta 5+40 - 5+30	NUMBER M-12



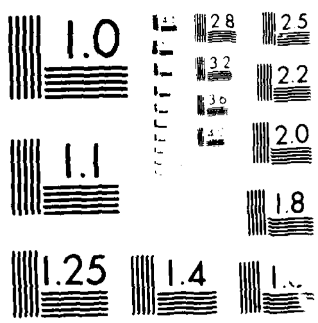
Uplift Cell Elev.

3	984.7 ±
14	985.0 ±
5	984.9 ±
6	985.5 ±
[illegible]	[illegible] ±
8	[illegible].6 ±



AD-A191 144 FOUNDATION REPORT ON STONEWALL JACKSON DAM WEST FORK RIVER BASIN WESTON W. (U) CORPS OF ENGINEERS HUNTINGTON WV HUNTINGTON DISTRICT D NUGEN 21 DEC 87 3/6

UNCLASSIFIED DACW59-83-C-0053 F/G 13/2 NL


1.0
2.8
2.5
3.2
2.2
3.6
2.0
1.1
1.8
1.25
1.4

STONEWALL JACKSON

UPLIFT PRESSURE CELLS

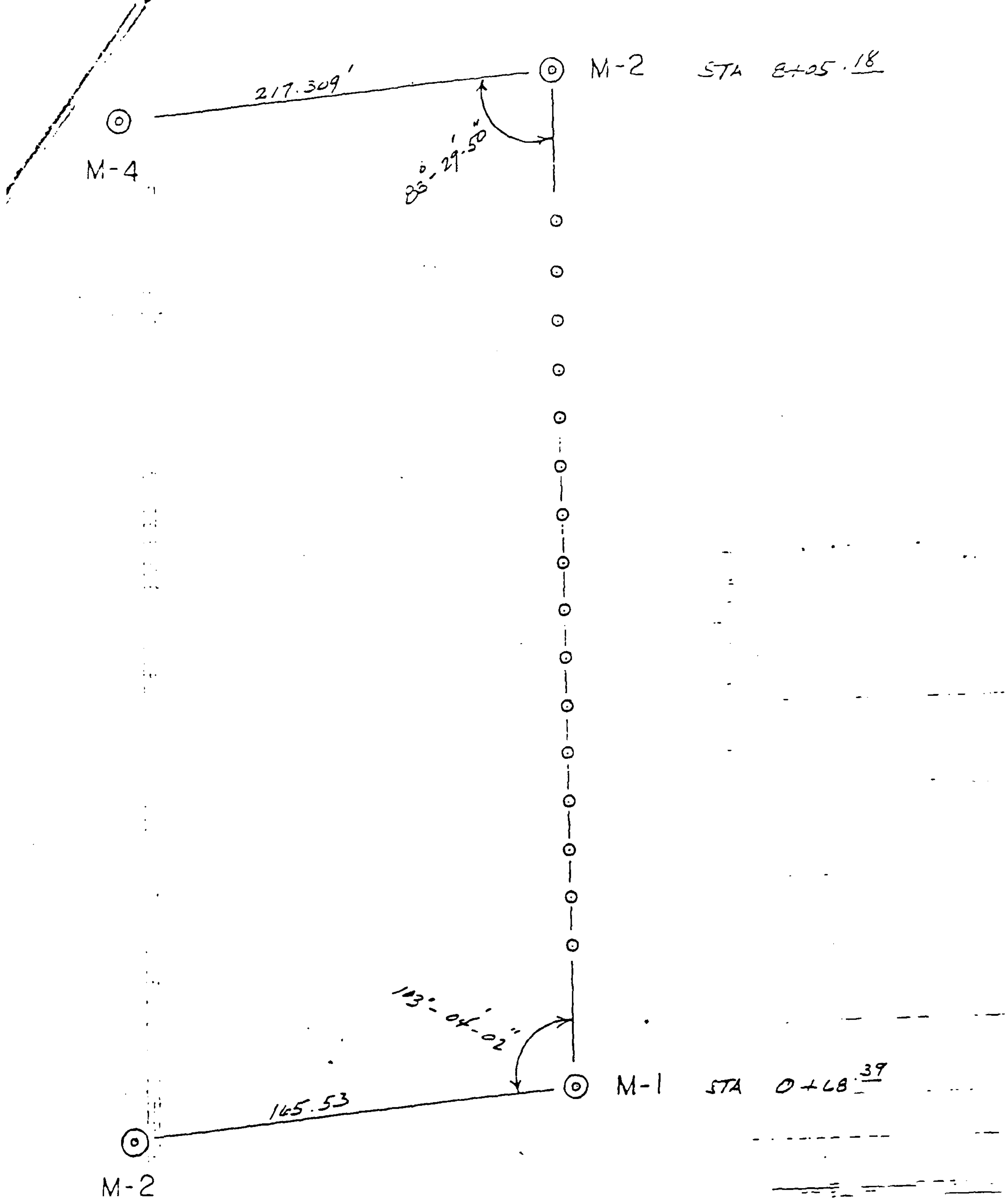
INST. NO.		7/28/86	7/29/86	7/30/86
:1	MON. 5	:8888.8:0-PSI	:1001.7:	:1001.2:
:2		:8888.8:0-PSI	:8888.8:0-PSI	:8888.8:0-PSI
:3		:8888.8:0-PSI	:1001.7:	:1001.7:
:4		:8888.8:0-PSI	:8888.8:0-PSI	:8888.8:0-PSI
:5		:1001.7:	:1001.7:	:1001.7:
:6		:8888.8:0-PSI	:8888.8:0-PSI	:8888.8:0-PSI
:7	MON. 8	:1013.9:	:1014.4:	:1013.9:
:8		:1015.0:	:1015.6:	:1014.4:
:9		:8888.8:0-PSI	:8888.8:0-PSI	:8888.8:0-PSI
:10		:8888.8:0-PSI	:1000.6:	:8888.8:0-PSI
:11		:8888.8:0-PSI	:8888.8:0-PSI	:8888.8:0-PSI
:12		:8888.8:0-PSI	:8888.8:0-PSI	:8888.8:0-PSI
:13	MON. 12	:1011.2:	:8888.8:0-PSI	:8888.8:0-PSI
:14		:1012.3:	:1012.3:	:8888.8:0-PSI
:15		:8888.8:0-PSI	:8888.8:0-PSI	:8888.8:0-PSI
:16		:8888.8:0-PSI	:8888.8:0-PSI	:8888.8:0-PSI
:17		:8888.8:0-PSI	:8888.8:0-PSI	:1012.3:
:18		:8888.8:0-PSI	:8888.8:0-PSI	:1010.6:
:POOL		:1015.0:	:1015.2:	:1015.1:
:T.W.		:1015.2:	:1015.2:	:1015.2:
:WEATH.		: 5.0:FOG	: 3.0:CDY	: 3.0:CDY
:A.T.		: 64.0:	: 70.0:	: 64.0:
:PRECIP.		: 0.0:	: 0.0:	: 0.0:

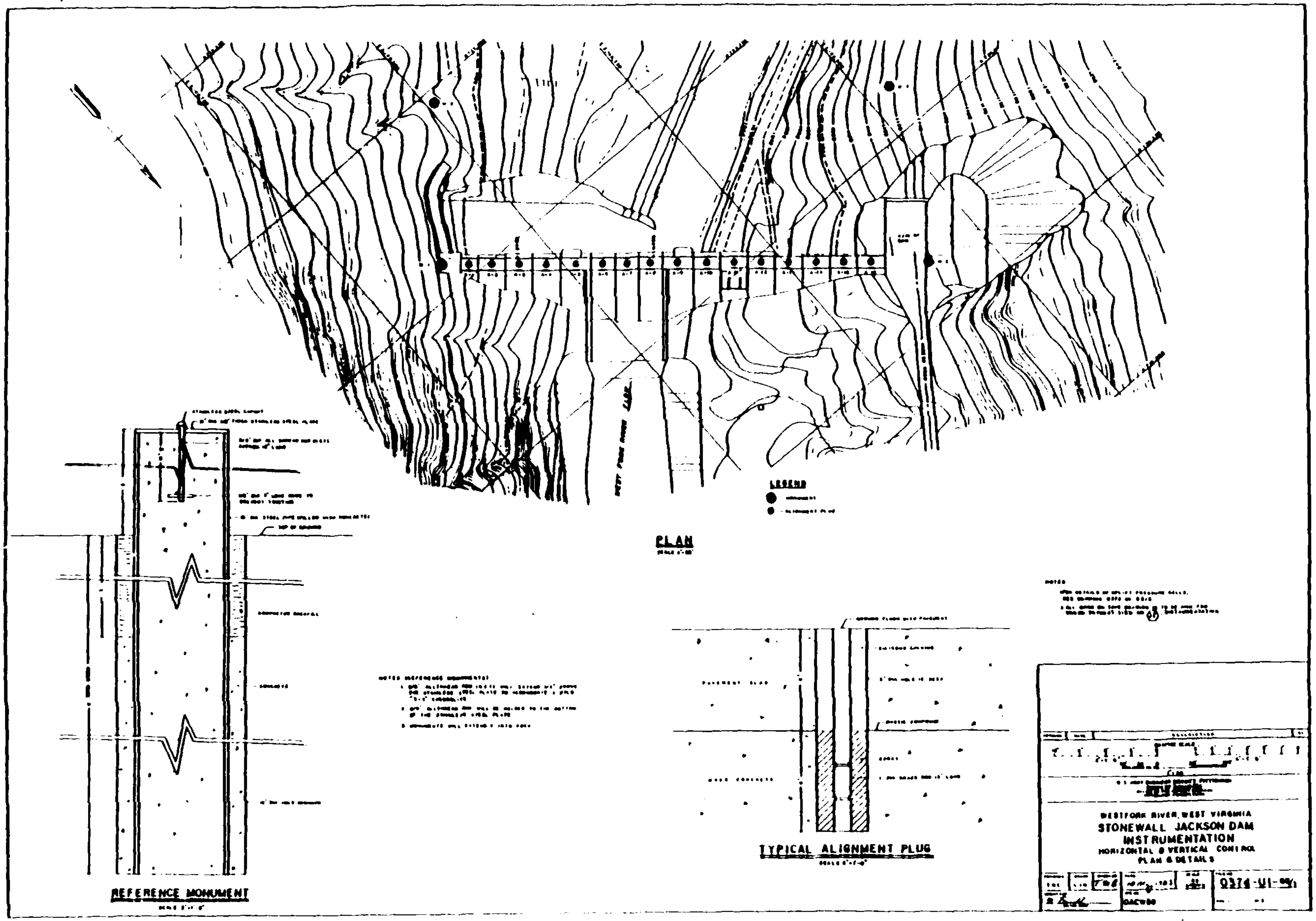
"O-2"

INSTRUMENTATION

(2) Horizontal and Vertical Controls

HORIZONTAL CONTROL




PLAN
LEGEND
REFERENCE MONUMENT
TYPICAL ALIGNMENT PLUG
WESTFORK RIVER, WEST VIRGINIA
STONEWALL JACKSON DAM
INSTRUMENTATION
HORIZONTAL & VERTICAL CONTROL
PLAN & DETAILS

10-01

"P"

ROCK ANCHORS

	SUBJECT	PAGE
(1)	Rock Cut Faces	P-2 - P-3
(2)	Stilling Basin	P-4 - P-6
(3)	Diversion Channel Area	P-7 - P-23

"P-1"

ROCK ANCHOR BOLTS

MONOLITH EXCAVATION FACES

Quan.	Size	(lf) Length	Install Date	Location
1 ea.	#11x20.0'	20.0	03-18-85	Downstream side of Stage I Diversion Channel; lt. abutment side
2 ea.	#11x20.0'	40.0	03-18-85	Mon. 13/14 joint u/s
2 ea.	#8x20.0'	40.0	03-15-85	Upstream side of Stage I Diversion Channel; rt. abut. side; verticals on top
2 ea.	#8x20.0'	40.0	03-15-85	Upstream side of Stage I Diversion Channel; rt. abut. side; through side
6 ea.	#8x18.5'	111.0	01-08-85	Mon. 16; Row B (first row down face)
8 ea.	#8x27.5'	220.0	01-07-85	Mon. 16; Row A; vertical top Mon. 16 approx. 6' from side
9 ea.	#11x20.0'	180.0	05-17-84	Row P; Mon. 2/3 joint
3 ea.	#11x25.0'	75.0	05-17-84	Row P; Mon. 2/3 joint
1 ea.	#11x30.0'	30.0	05-17-84	Row P; Mon. 2/3 joint
5 ea.	#11x30.0'	150.0	05-16-84	Row C; Mon. 2/3 joint
7 ea.	#11x20.0'	140.0	05-07-84	Row C; Mon. 2/3 line drilled face
15 ea.	#11x30.0'	450.0	05-07-84	Row C; Mon. 2/3 line drilled face
2 ea.	#11x19.5'	39.0	04-04-84	Row B; Upstream face above line drilling at Mon. 2/3 joint
3 ea.	#11x17.5'	52.5	04-18-84	Row B; Upstream face

				above line drilling at Mon. 2/3 joint
13 ea.	#11x17.5'	227.5	04-17-84	Row D; Mon. 2
4 ea.	#11x17.5'	70.5	04-12-84	Row C; Line drilled face downstream of Mon. 1 on Mon. 1/2 joint
3 ea.	#11x17.5'	52.5	04-11-84	Mon. 2/3; fist row Mon. 3
5 ea.	#11x17.5'	87.5	04-11-84	Mon. 2/3; second row Mon. 2
13 ea.	#11x17.5'	227.5	03-20-84	Row C; Mon. 2
2 ea.	#22x17.5'	35.0	03-20-84	Mon. 2 face
5 ea.	#11x17.5'	87.5	03-20-84	Mon. 3 face
3 ea.	#11x17.5'	52.5	03-20-84	Mon. 2 face
13 ea.	#11x17.5'	227.5	03-14-84	Row B; Mon. 1
5 ea.	#11x19.5'	97.5	03-12-84	Retaining wall above Mon. 1
9 ea.	#11x19.5	175.5	03-12-84	Row A; Mon. 1

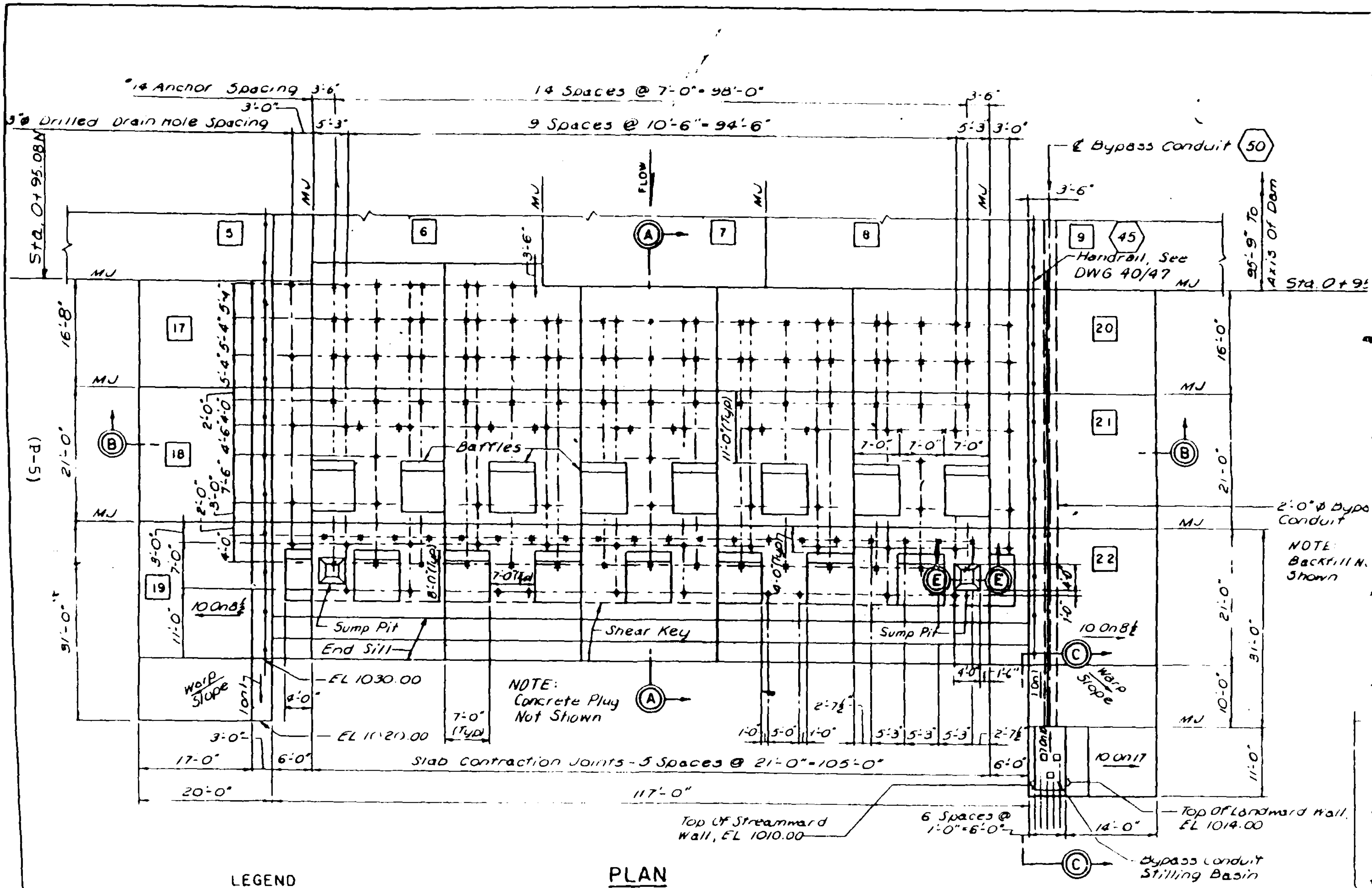
"P-2"

FOUNDATION ANCHORS

STILLING BASIN

Resteel - 14-S Bars

Date	Mark	Quantity	Unit Weight/Ft	Total Weight/lb
12-20=84	14-S-2	7	7.65	1557.41
Additional	14-S-2	20	7.65	4449.24
12-17-84	14-S-2	7	7.65	1557.41
12-11-84	14-S-2	7	7.65	1557.41
12-10-84	14-S-2	5	7.65	1112.44
11-29-84	14-S-2	5	7.65	729.94
11-27-84	14-S-2	8	7.65	1626.88
Additional	14-S-2	9	7.65	1790.10
11-19-84	14-S-2	5	7.65	1112.44
11-14-84	14-S-1	6	7.65	1220.18
11-13-84	14-S-2	7	7.65	1557.41
11-05-84	14-S-2	7	7.65	1557.41
10-27-84	14-S-2	5	7.65	1112.44
10-24-84	14-S-1	6	7.65	1230.16
10-17-84	14-S-2	4	7.65	889.65
10-15-84	14-S-1	6	7.65	24280.[illegible]4



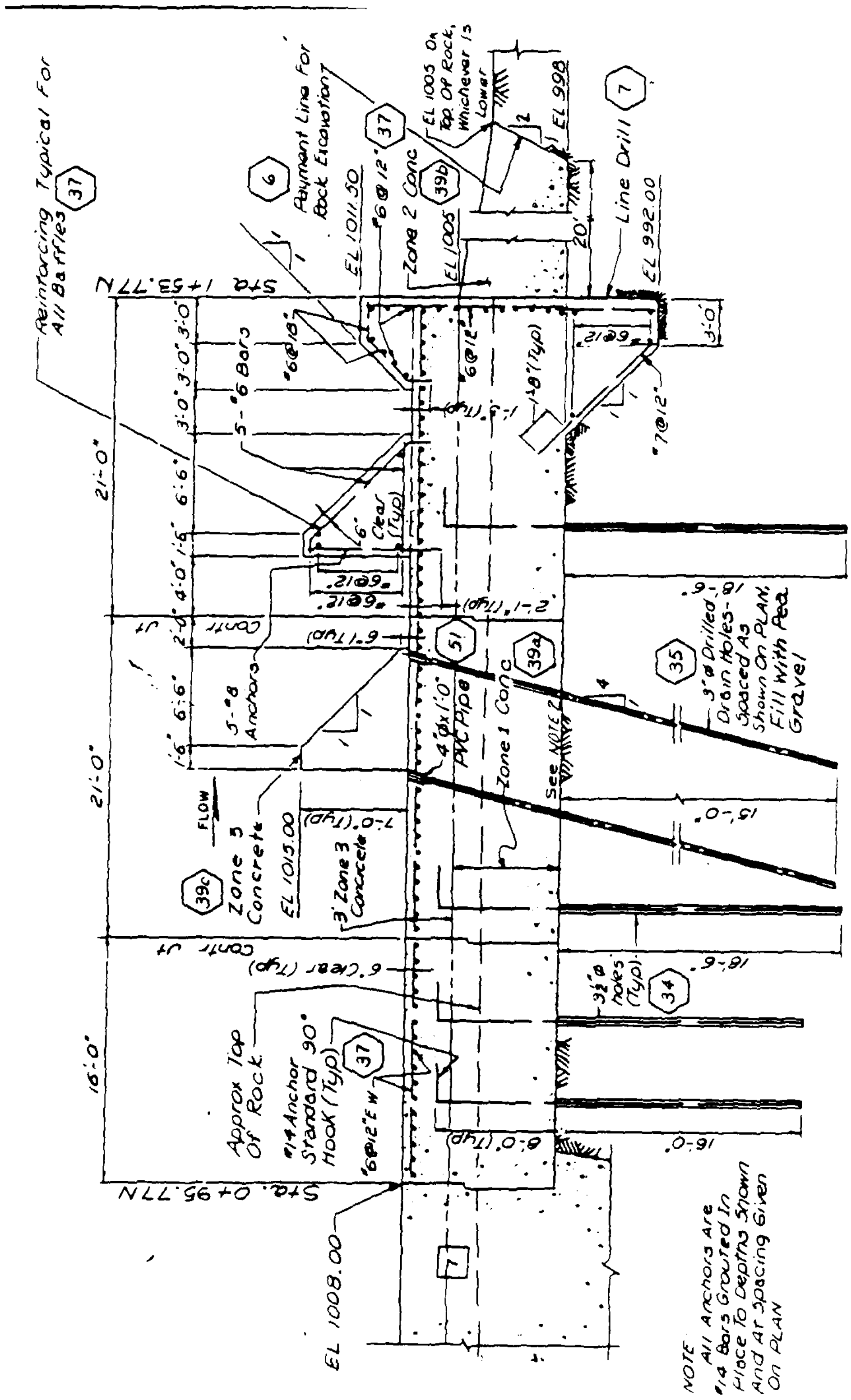
PLAN

(STILLING BASIN)
SCALE: 1" = 10'

LEGEND

⊕ — DRAIN, 4" Ø x 1'-0" PVC PIPE IN CONCRETE AND 3" Ø DRAIN HOLE IN CONCRETE AND ROCK.

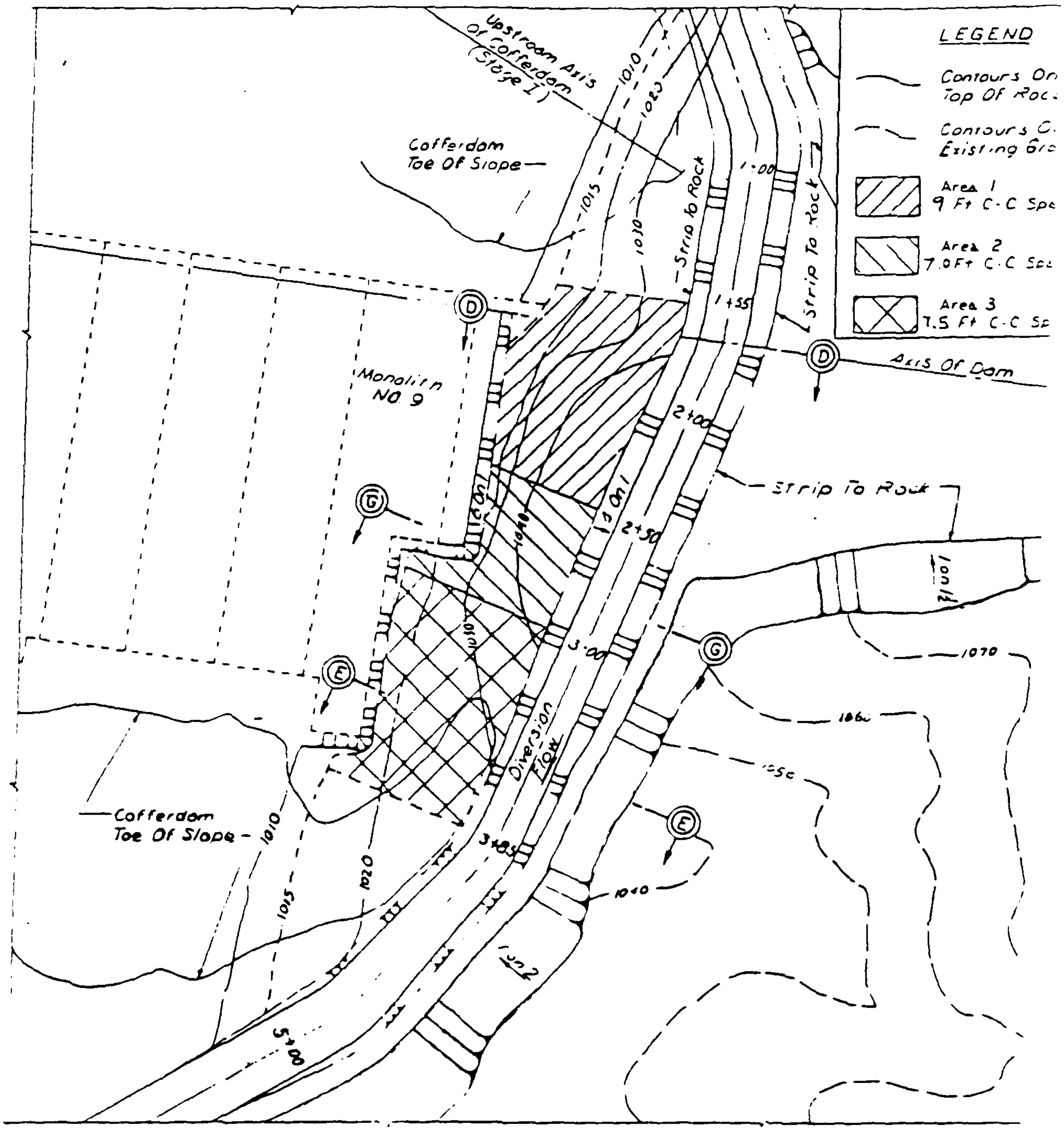
X — ANCHOR, #14 BAR GROUTED IN $3\frac{1}{2}$" Ø HOLE.


Reinforcing Typical For All Baffles
37
6
Payment Line For Rock Excavation
37
#6@12"
EL 1011.50
Zone 2 Conc
39b
EL 1005 Or Top Of Rock, Whichever Is Lower
EL 998
7
Line Drill
EL 992.00
EL 1005
20'
Sta. 1+53.77N
21'-0"
21'-0"
16'-0"
3'-0" 3'-0" 3'-0" 3'-0"
5-#6 Bars
#6@12"
6@12"
18"(Typ)
1'-3"(Typ)
#7@12"
6'-6"
6" Clear (Typ)
1'-6"
4'-0"
#6@12"
#6@12"
2'-1"(Typ)
2'-0"
Contr Jt
6"(Typ)
51
39a
4"ϕx1'-0" PVC Pipe
Zone 1 Conc
See NOTE 2
35
3"ϕ Drilled Drain Holes-Spaced As Shown On PLAN. Fill With Pea Gravel
18'-6"
6'-6" 6'-6" 1'-6"
5-#8 Anchors
FLOW
15'-0"
39c
Zone 5 Concrete
EL 1015.00
7'-0"(Typ)
3' Zone 3 Concrete
Contr Jt
6" Clear (Typ)
18'-6"
3½"ϕ holes (Typ)
34
Approx Top Of Rock
#14 Anchor Standard 90° Hook (Typ)
37
#6@12" E.W.
6'-0"(Typ)
16'-0"
Sta. 0+95.77N
EL 1008.00
7
NOTE
All Anchors Are #14 Bars Grouted In Place To Depths Shown And At Spacing Given On PLAN

"P-3"

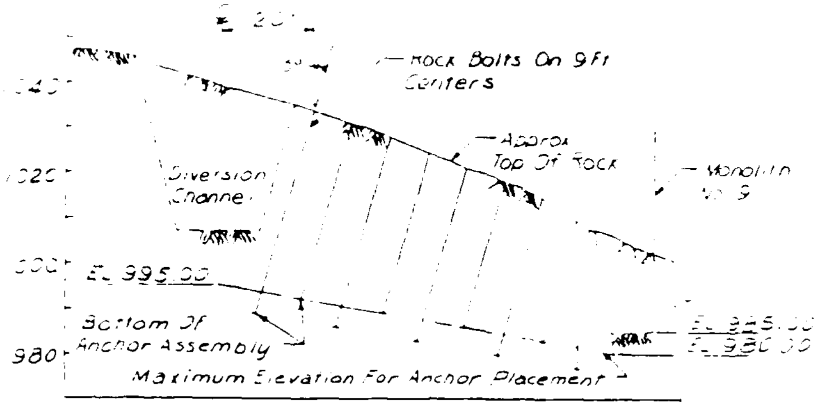
ROCK ANCHOR PROGRAM

DIVERSION CHANNEL AREA

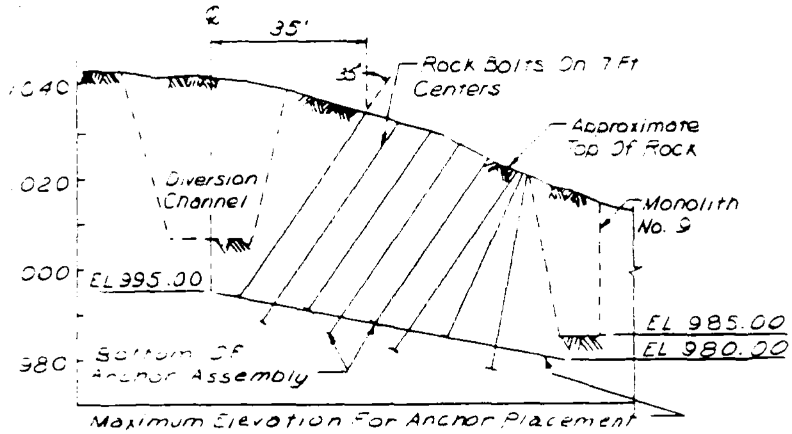


PLAN

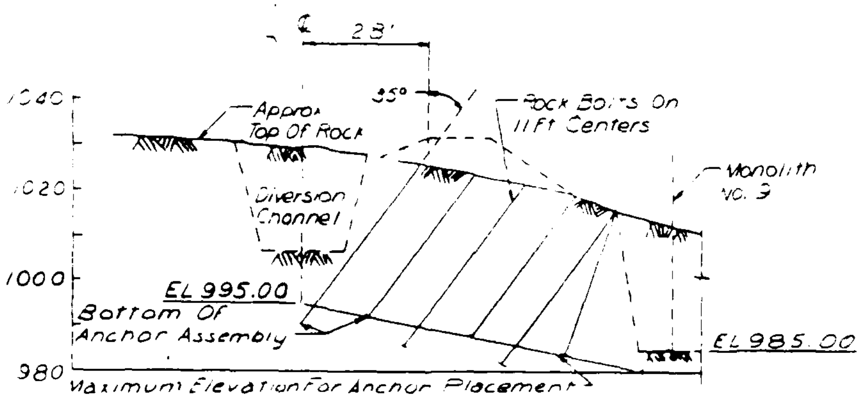
SCALE 1" = 30'



D-D



G-G

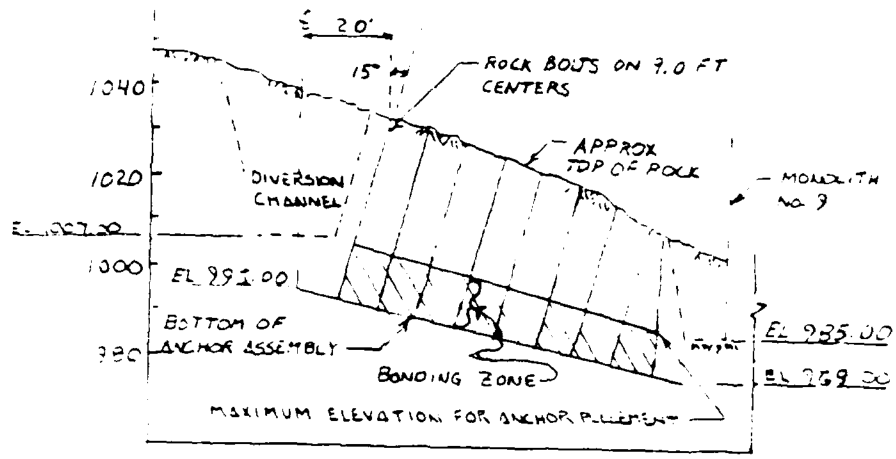


E-E

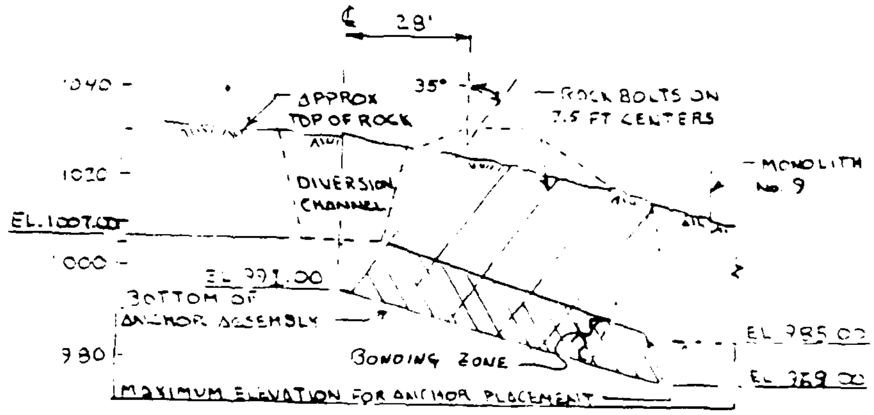
SECTIONS

SCALE: 1" = 20'

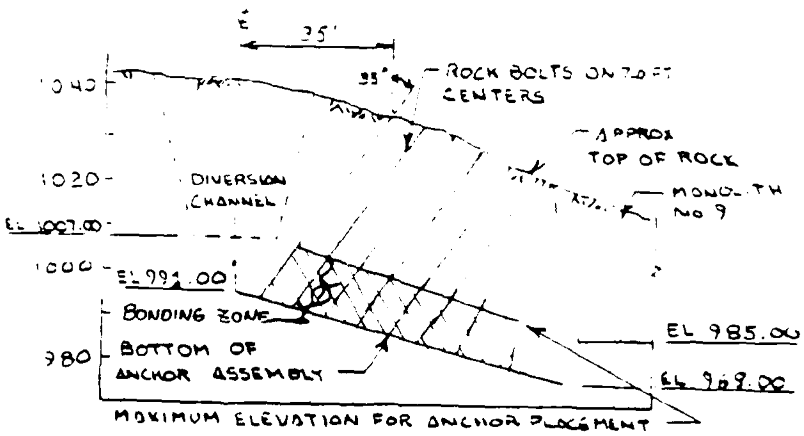
PER DESIGN - USING WILLIAMS R1S MECHANICAL BOLT



D-D

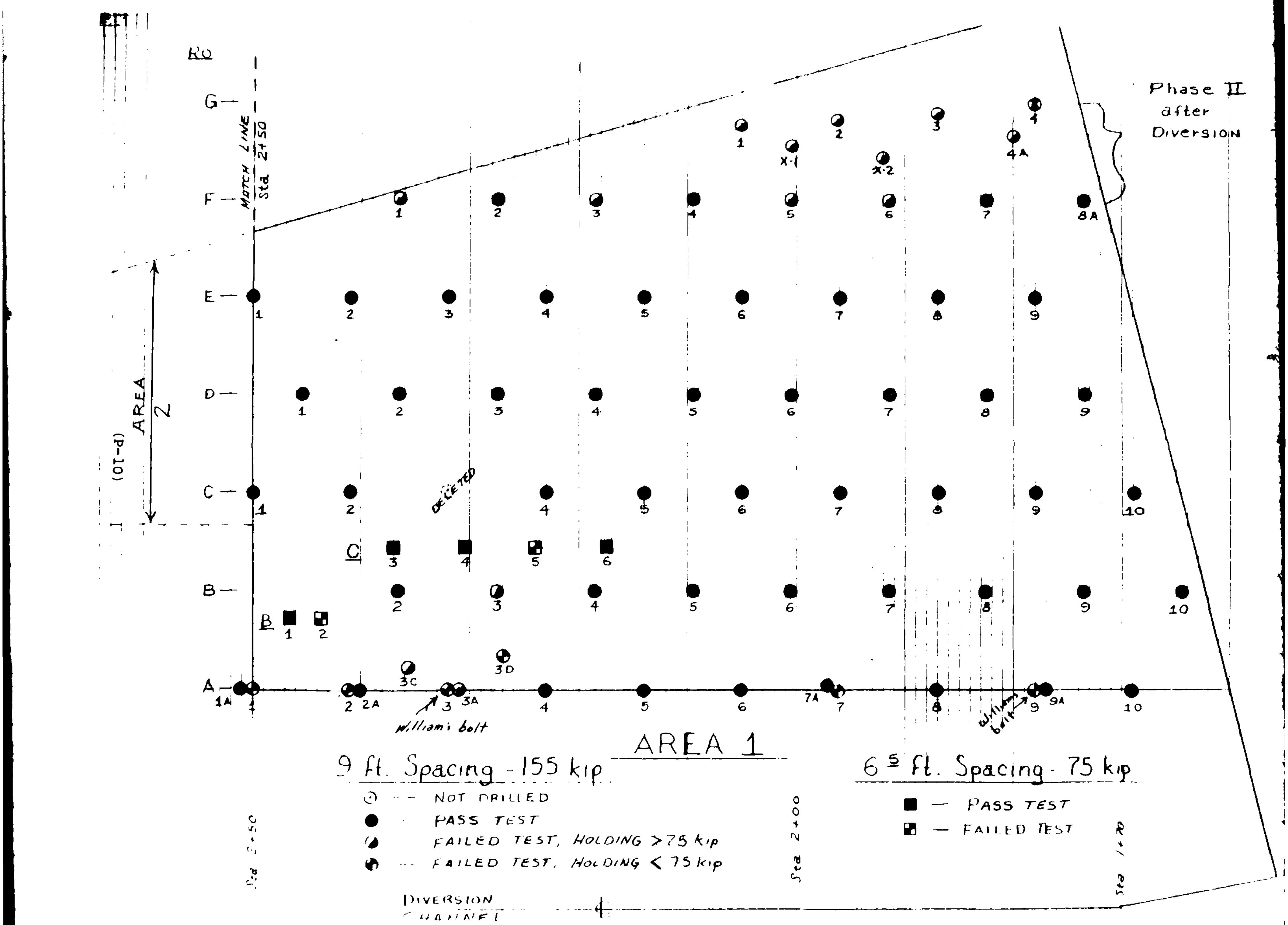


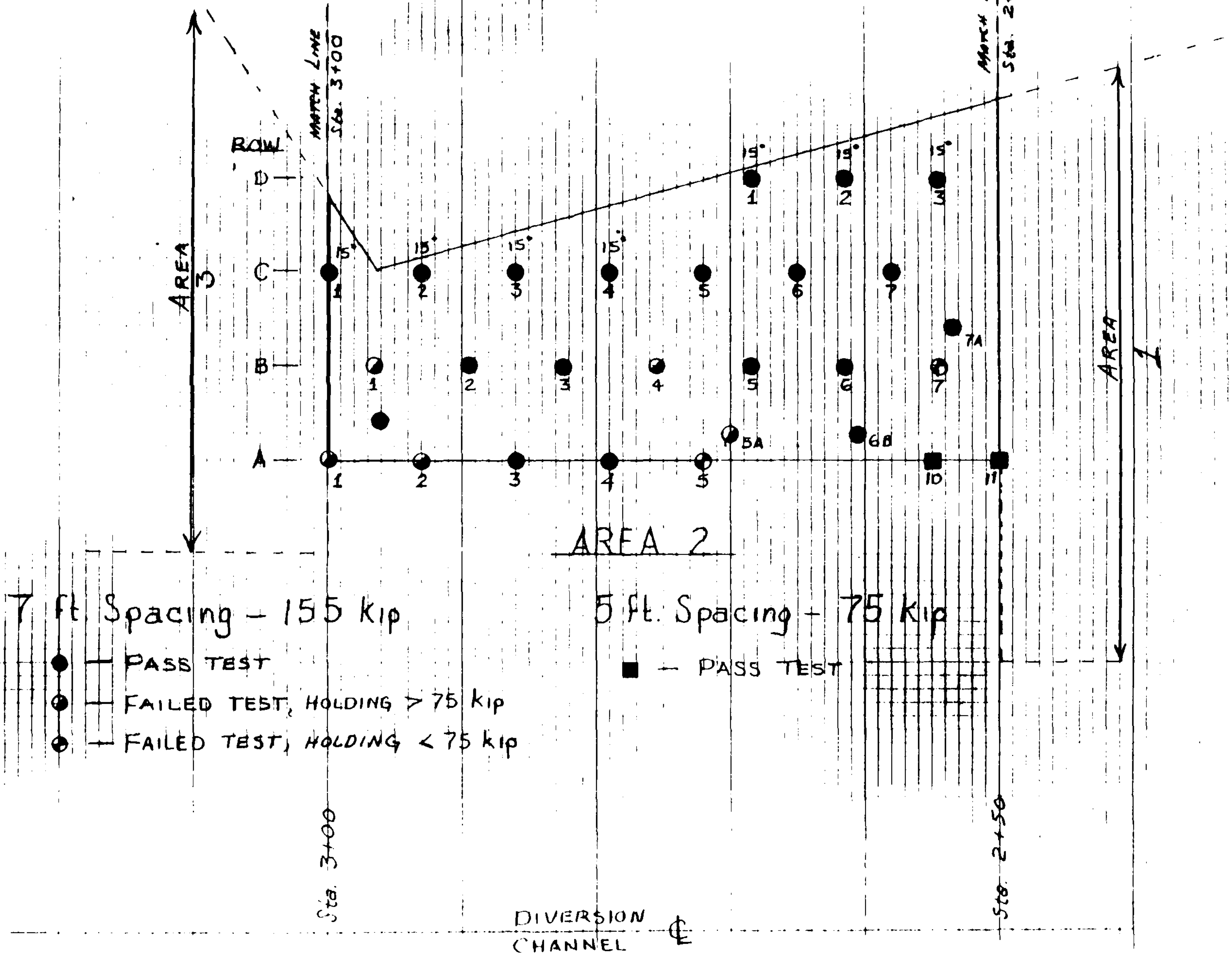
E-E

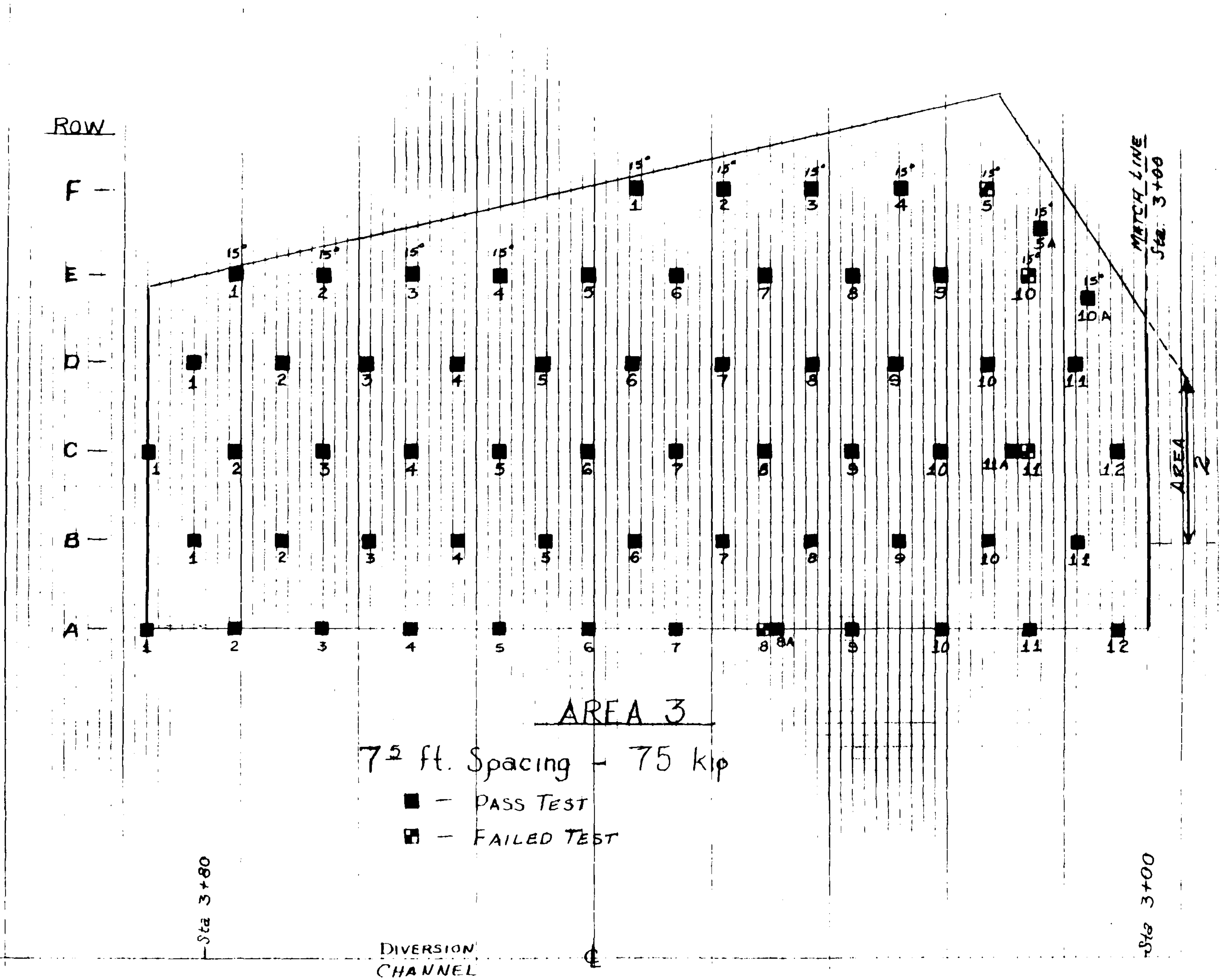


G-G

AS BUILT - USING DYWIDAG GRADE 150 BAR W/CELTITE BONDING RESIN


Phase II after Diversion
MATCH LINE Sta 2+50
AREA 2
(P-10)
DELETED
William's bolt
AREA 1
9 ft. Spacing - 155 kip
NOT DRILLED
PASS TEST
FAILED TEST, HOLDING > 75 kip
FAILED TEST, HOLDING < 75 kip
6.5 ft. Spacing - 75 kip
PASS TEST
FAILED TEST
Sta 2+00
DIVERSION CHANNEL


AREA 3
AREA 2
AREA 1
MATCH LINE Sta. 3+00
MATCH LINE Sta. 2+50
ROW
D
C
B
A
15°
1A
5A
6B
7A
10
11
7 ft. Spacing – 155 kip
— PASS TEST
— FAILED TEST, HOLDING > 75 kip
— FAILED TEST, HOLDING < 75 kip
5 ft. Spacing – 75 kip
— PASS TEST
Sta. 3+00
Sta. 2+50
DIVERSION CHANNEL ℄


ROW
F
E
D
C
B
A
15°
MATCH LINE
Sta. 3+00
AREA 2
AREA 3
7.5 ft. Spacing - 75 kip
■ - PASS TEST
- FAILED TEST
Sta 3+80
Sta 3+00
DIVERSION CHANNEL
℄

ROCK ANCHOR PROGRAM SYNOPSIS

DIVERSION CHANNEL AREA

On 24 and 25 August 1983, the contractor conducted a test on three rock anchors (1A1, 1A2, and 1A7). He used the grade 150 (1-3/8 inch dia.) prestressed steel dywidag bar in a 2 inch diameter hole with celtite (4512) bonding resin (9 cartridge in 1A2 and 1A7 and 11 cartridge in 1A1). The tests were conducted under the supervision of Mr. Gary Greenfield, Celtite representative. All three anchors failed to obtain the 155 kip stress requirement. Two failed in the 95 kip range and the third at 75 kip. Mr. Greenfiled concluded from his resin anchorage chart, relationship of failure point to length of resin anchor bond and field experience that we were dealing with weak rock criteria and from the three test results, he suggested that the Corps of Engineers re-evaluate rock conditions with considerations given to increasing the number of anchors thus lowering the stress yield requirement for each anchor.

On 01 September 1983, the contractor had Mr. Mike Fitzpatrick, representing Williams Rock Anchors, supervise the installation and stressing of two rock anchors using the contract specified (Section 2N, par. 3.3.3) 2 inch diameter RIS bolt. Corps of Engineers personnel present for this test were Mr. P. Oshel, ORH and Mr. J. Brown and Mr. A. Krysa, ORP. The two bolts were installed in the same area as the previously tested dywidag bolts and both (1A3 and 1A9) failed to obtain the required stress of 155 kips, 1A9 failed at 86 kips and unable to obtain any stress readings on 1A3. It should be noted here that anchor 1A3, that achieved zero stress results was located in an area that was later discovered during the rock anchor program to be an area that positive results could not be obtained. After the failure of the two Williams bolts, Mr. Fitzpatrick told the group that he did not know what the problem was but felt that required results could possibly be achieved by adjusting procedures, such as using double anchor cones.

A meeting was held in the Resident Engineer's Office. Present were Mr. Brown and Mr. Krysa, ORP; Mr. Oshed, ORH; Resident Engineer, Mr. Woodburn, Assistant Resident Engineer, Mr. Loudin and myself from the project office. We discussed the previous test results and concluded that the most feasible solutions to the problem was to let the contractor select a lesser bolt size/spacing/stress requirement (see attached sheet), which would satisfy design criteria and submit it to the District Office for approval.

The contractor selected the spacing compatible with the 75 kip stress requirement which had been exceeded during the test for the dywidag anchors previously. Another requirement imposed upon the contractor in using the dywidag bar was that he must have at least 10 vertical feet of resin bond for each anchor installed with a maximum top elevation of 1005 near the diversion channel to elevation 985 at Monolith No. 9.

With knowledge that the 75 kip yield strength would be no problem, the contractor ordered the No. 11, grade 60 dywidag bar, which met the 75 kip yield strength requirement before program approval from the District Office. The supplier did not have the No. 11 bar in stock, so the contractor obtained the Grade 150, 1-3/8 inch diameter bar that had been used in the initial testing. On 08 September 1983, the contractor started his revised rock anchor program. He had problems inserting resin cartridge in a 2 inch diameter hole, such as was used during the test program, so he went to a 2-1/4 inch diameter hole and in problem areas, such as in Area 1, he drilled a 3-1/2 inch diameter hole to the top of the bonding zone and changing to a 1-1/4 inch diameter bit to complete the hole.

On 12 September 1983, the contractor performed the first stress test on 16 installed anchors. Two anchors failed the 75 kip requirement and 2 of the satisfactory anchors (1C4 and 3A3) were stressed beyond the 75 kip requirement. 1C4 had cap rock failure at 126 kips but 3A3 achieved 159 kips before the test was stopped because of bar limitation. Although not suggested by Mr. Greenfield during the initial testing of the dywidag bars, the stress yield on a bar is directly related to length of resin anchor bond. In the 15 degree angle holes in area 1, it took 12-4512 resin cartridges to obtain the 10 foot vertical bonding zone. In a 2-1/4 inch diameter hole with a 1-3/8 inch diameter bar installed, the 4512 resin cartridge produces 12 inches of bonding length. Thus, the 12 cartridges used produced a total of 144 inches bond length. On the resin anchorage chart under weak rock criteria, 1 inch bonding length produces approximately 1.1 kips. Thus the 144 inches bonding length theoretically should obtain 159.5 kips.

Thus, with the resin anchorage chart data substantiated with field test results, the contractor was instructed to return to the original spacing/stress yield requirements with two adjustments. (1) Area 3, which by then was over 50% completed, could be finished using the closed spacing/lower stress yield program. (2) In Areas 1 and 2, remaining anchor holes would be drilled 4 feet deeper than originally scheduled so that an additional 4 celtite cartridges could be added to each hole, for a safety factor, giving a total of 16 cartridges for each anchor.

With the implementation of the above procedure, the rock anchor program was completed on 27 September 1983, except for 2 rows (12 anchors) on the river side of Area 1. After Stage 1 cofferdams

had been constructed and the coffered area had been dewatered, the diverison channel area rock anchor program was continued and completed between 14 December and 20 December 1983.

This phase of the program consisted of removing the overburden and installing the two riverward rows (F and G) of rock anchors in Area 1. The rock surface exposed by the removal of the overburden consisted of weak, thin bedded, silty sandstone and siltstones that underlay the massive sandstone cap rock that was predominant in Area 1 during Phase 1. This softer material presented a problem during the anchor stressing procedure in that the rock beneath the anchor plate failed before the anchor rock could be stressed to the 155 kip requirement. The contractor tried to eliminate this problem by using a wider base plate (1.5' x 1.5' x 1") but was only partially successful. Even with the larger plates, only 4 of the original 12 rods could be stressed to 155 kips. 6 rods that had cap rock failure during resin but held 75+ kip were suplimented with 2 additional rods (GX-1 and GX-2) in the general area and of the two remaining anchors which had bar failure. The one which held below 75 kip, (G-4), was replaced by another anchor (G-4A).

Drilling Equipment - 2 Joy Ram Drills - Model VCR 260 E
2 Joy 850 Air Compressors - Model RPQ800

Drilling Bits - 2", 2-1/4", 2-1/2", 3" and Dia. Plug Bit

Bar Installations - Groves TMS 300 LP Crane

Anchor - Dywidag - Grade 150 (1-3/8" dia.)

Resin - Celtite - 4512

Testing - 60 MP Jack, Series 04

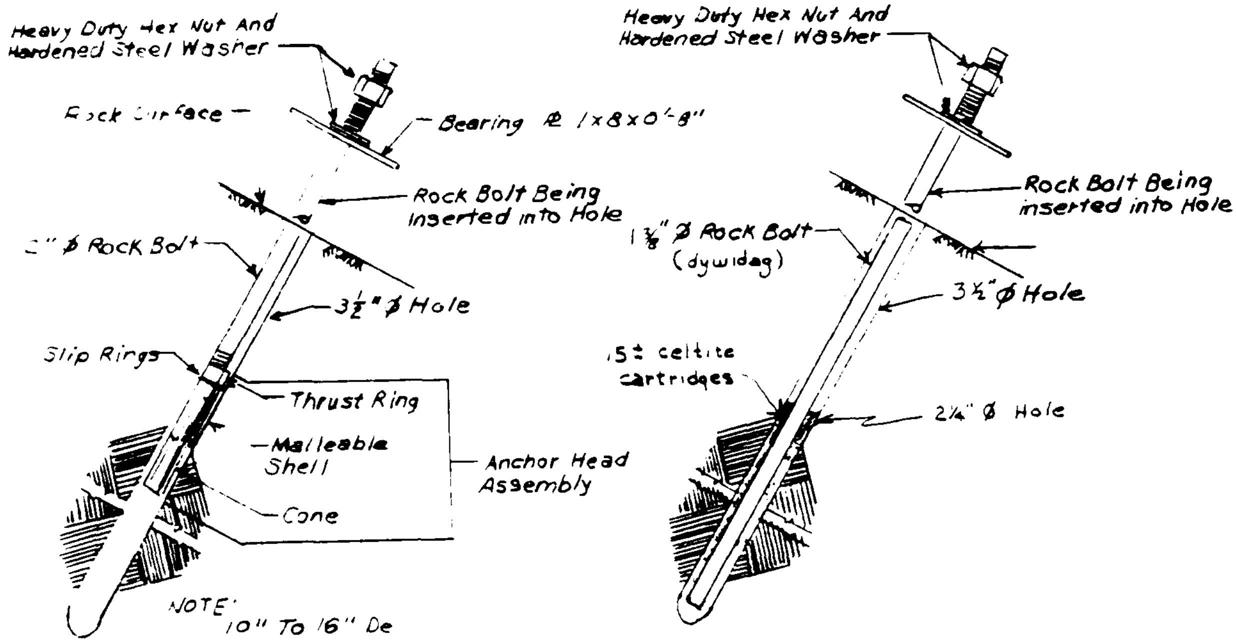
Installation Procedure

Drill required diameter hole, usually 2-1/4 inch diameter, from the top of rock to calculated depth, depending upon hole location and angle. After reaching required depth, clean hole with air and water, if encountered during drilling; pull drill rods and check hole depth with 1 inch diameter PVC pipe. If open, proceed to celtite cartridge installation. If hole is not open to bottom, clean out hole by redrilling or remaining the 3-1/2 inch diameter bit to top of bonding zone; insert 2 inch I.D. PVC pipe to top of 2-1/4 inch diameter hole, remove bit from drill rod and clean hole to bottom using air thru string of open drill rods. If this does not open the hole, the hole was abandoned, move 1 foot, more or less, redrilled. The celtite cartridge was dropped through the open hole, or 2 inch diameter PVC pipe if applicable, using the 1 inch diameter PVC pipe at various intervals to assure proper seating of the cartridges. A dywidag bar was cut to a length

equal to the drilled hole depth plus 2.5 feet stick-up for testing purposes. The bar was lifted by one end by the crane; centered over the hole and inserted by hand guidance until the drill with adapter socket could move over bar. The drill then seated the bar by slowly rotating it to the bottom of the hole and then spinning the bar at approximtely 100 RPM for 30 seconds. The adaptor was then removed form the bar and the drill move to the next anchor location.

Testing

After the anchor plate had been installed at the correct angle, 90 degrees to bar angle, and nut set and after an appropriate time for resin set (minimum of 35 min.), the bar was stressed. On the bars requiring 155 kips, stopping points for nut tightening and elongating measurement were 51, 87, 123, and 155 kips. If a bar failed, its hole kip was considered as to whether to replace it with another anchor or to supplement it with a closed spaced anchor.



MECHANICAL ANCHOR

AS DESIGNED

GROUTED ANCHOR

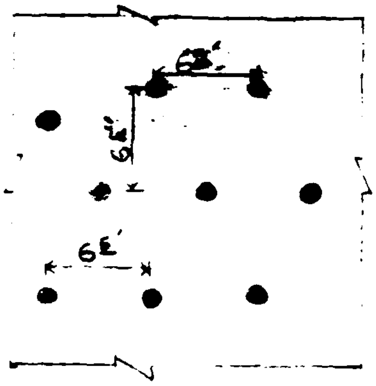
AS USED

ROCK BOLT DETAIL

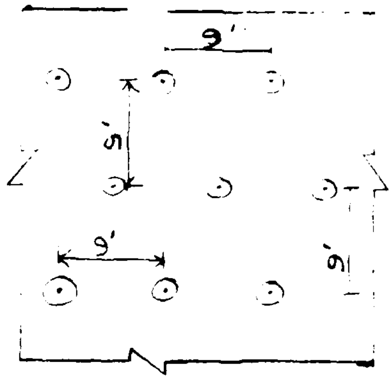
NO SCALE

WEST FORK RIVER
STONEWALL JACKSON LAKE
DAM
STAGE I—DIVERSION
ROCK STABILIZATION

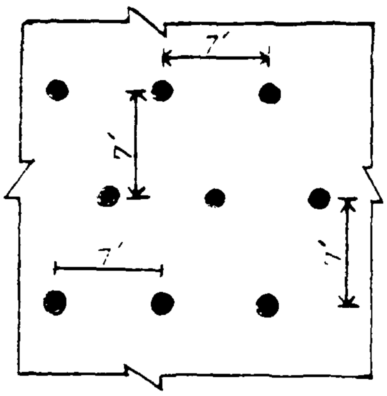
Rock Anchor Bolts
Diversion Channel
Spacing For Load Required



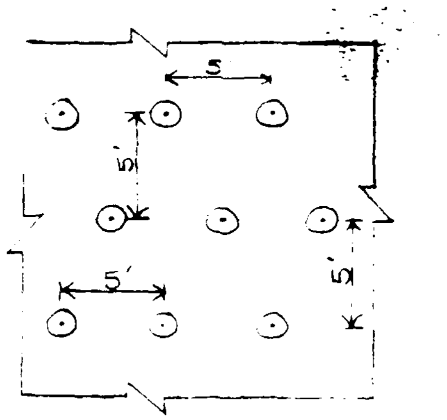
Area 1
(As built)



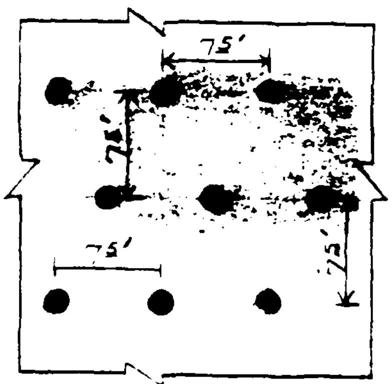
Area 1



Area 2
(As built)

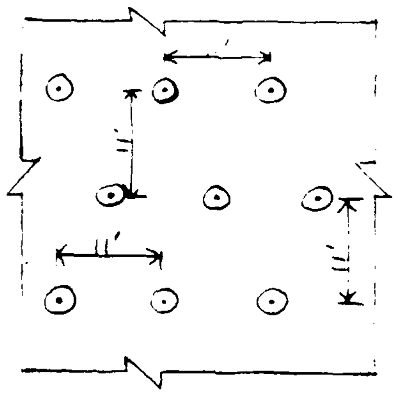


Area 2



Area 3
(As built)

Alternative
(75 kip)



Area 3

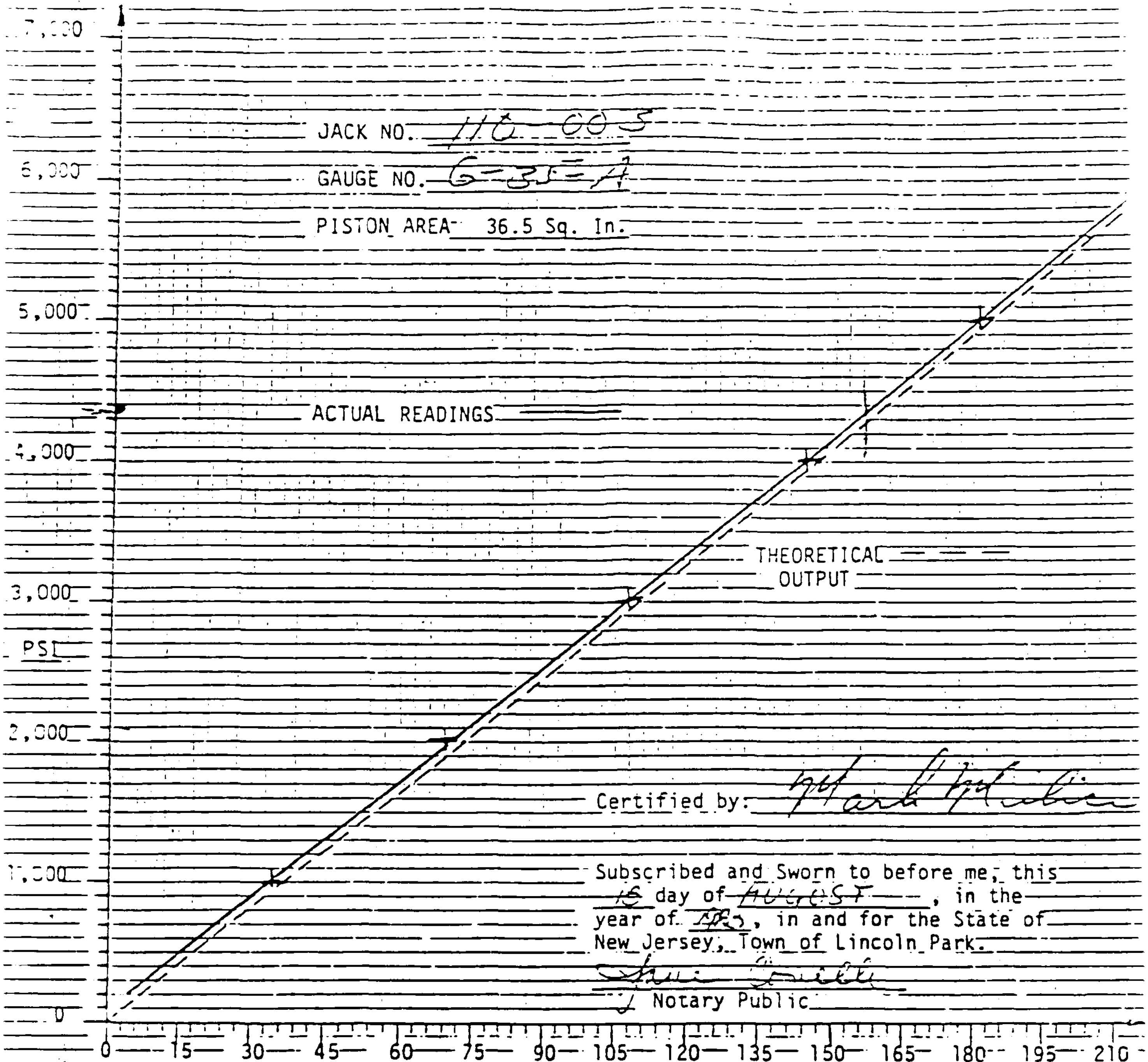
Designed
(155 kip)

SUMMARY (PRE-DIVERSION)
ROCK BOLT PROGRAM - DIVERSION CHANNEL
STONEWALL JACKSON LAKE PROJECT

LOCATION	155 KIP INSTALL	155 KIP FAIL	75 KIP INSTALL	75 KIP FAIL	SUB-TOTAL INSTALL	SUB-TOTAL FAIL	% FAILURE	DRILL FOOTAGE LIN. FT.	BAR LENGTH INC. STICKUP LIN. FT.
Area 1	53	9	6	2	59	11	18.6	2909	3051.1
Area 2	26	7	2	0	28	7	25.0	1466	1536.0
Area 3	--	-	65	4	65	4	6.0	3067	3229.5
TOTAL	79	16	73	6	152	22	14.4	7442	7817.0
Phase II (Post Diversion)									
Area 1	12	2	3	0	15	2	13.0	605	642.5
Program Totals									
Area 1	65	11	9	2	74	13	17.0	3514	3694.0
Area 2	26	7	2	0	28	7	25.0	1466	1536.0
Area 3	--	--	65	4	65	4	6.0	3067	3220.5
TOTALS	91	18	76	6	167	24	14.0	8047	8459.5

SUMMARY

No. Bars Installed	167
No. Bars Fail	24
Per Cent Failure	14%
Avg. Length Bar	50.7 ft.



Certified by: [signature]

Subscribed and Sworn to before me, this 15 day of AUGUST, in the year of 1983, in and for the State of New Jersey, Town of Lincoln Park.

[signature]
Notary Public

JANE L. COVELLI
NOTARY PUBLIC OF NEW JERSEY
My Commission Expires Sept. 22, 1987

*CALIBRATION OF 110 MP JACK

8/18/83

252490

*Calibrated with
Procequ Dynamometer
Serial No. ZD 10013212

DYWIDAG-SYSTEMS INTERNATIONAL U.S.A. INC. DSI

(P-20)

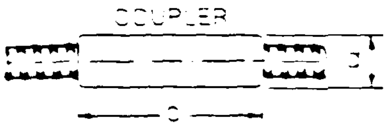
DYWIDAG System Details

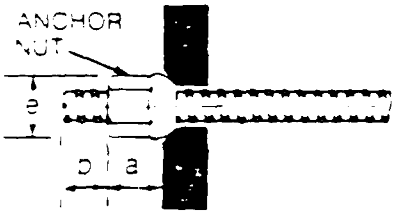
Prestressing steel – ASTM A 722

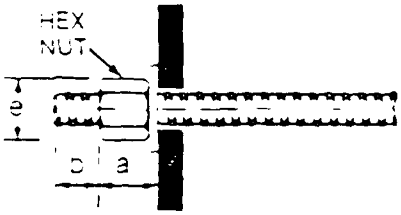
Right hand thread

Nominal Threadbar Diameter (inches)	Ultimate Stress (f_{pu}-ksi)	Cross Section Area A_{ps}-inches²)	Ultimate Strength ($f_{pu}A_{ps}$) (kips)	Weight (lbs./ft.)	Maximum Threadbar Diameter (inches)	Coupler Diameter d (in.)	Coupler Length c (in.)	Anchor Nut Length a (in.)	Hex Nut Length a (in.)	Width e (in.)
⅝	157	0.28	43.5	0.98	0.750	1.250	4.50	1.625	2.00	1.25
[illegible]	150*	0.85	127.5	3.01	1.125	2.000	5.50	1.875	2.50	1.75
1¼	150*	1.25	187.5	4.39	1.437	2.375	6.75**	2.50	3.125	2.125
1⅜	150*	1.58	237.0	5.56	1.562	2.625	8.625	2.75	3.50	2.375

"b" is the minimum threadbar protrusion (in inches) to accommodate prestressing, proof loading or coupling. "b" = ½ c + ½"
*Grade 160 Dywidag Threadbars available on special order when lead time permits. **7½" long coupler available on special order







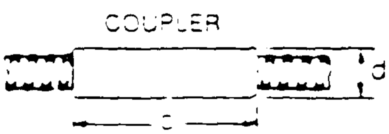
Resin anchors using Dywidag prestressing steel may be proof stressed to 80% of the guaranteed ultimate strength of the prestressing steel. Final working force should not exceed 60% of the guaranteed ultimate strength of the prestressing steel.

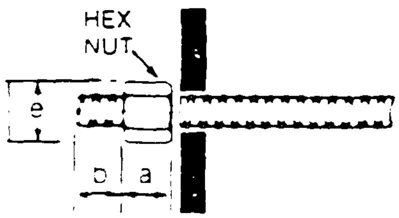
Reinforcing steel – ASTM A 615 (Grade 60)

Left hand thread for size #6 thru #11 and right hand thread for #14 and #18

Threadbar Size Designation	Nominal Threadbar Diameter (inches)	Cross Section Area A_s-inches²)	Yield Strength ($f_y A_s$-kips)	Weight (lbs./ft.)	Maximum Threadbar Diameter (inches)	Coupler Diameter d (in.)	Coupler Length c (in.)	Hex Nut Width e (in.)	Hex Nut Length a (in.)
#6	0.750	0.44	26.4	1.502	0.812	1.125	3.500	1.125	1.000
#7	0.875	0.60	36.0	2.044	1.000	1.312	3.750	1.250	1.250
#8	1.000	0.79	47.4	2.670	1.125	1.500	4.000	1.437	1.375
#9	1.128	1.00	60.0	3.400	1.187	1.687	4.250	1.625	1.625
#10	1.270	1.27	76.2	4.303	1.437	1.875	5.000	1.750	1.875
#11	1.410	1.56	93.6	5.313	1.562	2.125	6.000	2.000	2.000
#14*	1.693	2.25	135.0	7.65	1.875	2.687	7.500	2.500	3.500
#18*	2.257	4.00	240.0	13.60	2.500	3.500	10.000	3.250	4.000

"b" is the minimum threadbar protrusion (in inches) to accommodate prestressing, proof loading or coupling. "b" = ½ c + ½"
*Coupler and hex nuts #14 and #18 develop 100% of the guaranteed ultimate strength





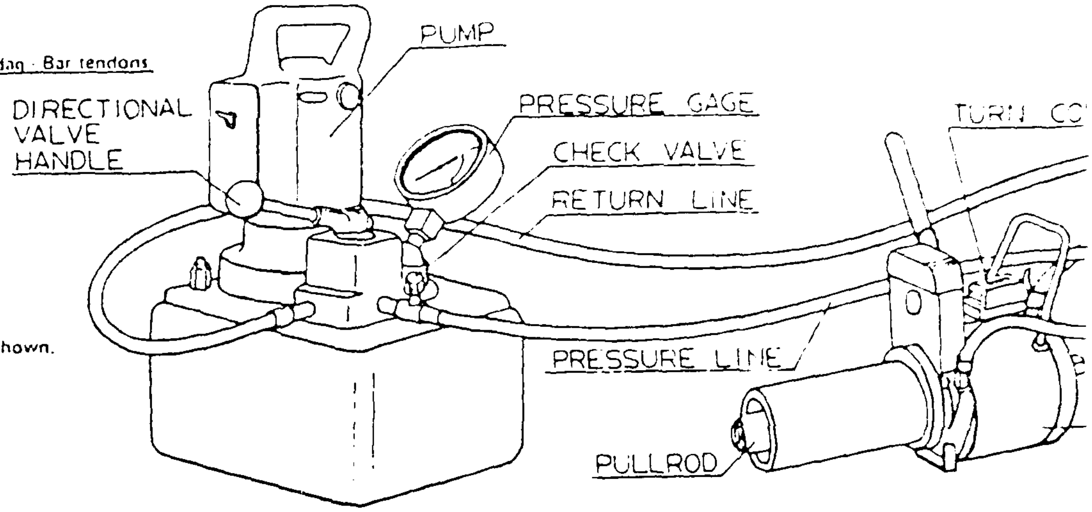
SATISFACTORY

FEB 25 1982

Resin anchors using Dywidag reinforcing steel may be proof stressed to 90% of the guaranteed yield strength of the reinforcing steel. The final working force varies with the application and function of the anchors.

Stressing the Dywidag - Bar tendons

Setup of Equipment

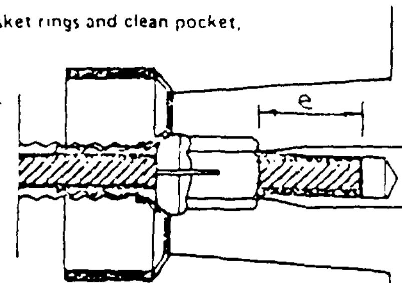


Connect hoses as shown.

Remove plastic pocket formers, cardboard gasket rings and clean pocket, nut and tendon threads.

Measure projection of bar beyond the anchor

Screw pullrod onto the bar until it touches the nut. Unscrew 1/8 turn.



Be sure that the bar extension "e" is at least 2 3/4" for the 1" Ø bar and 3" for the 1-1/4" Ø bar (not less than four full threads).

Place jack so that socket wrench fits snugly over the anchor nut. Screw pullrod nut onto the pullrod behind the jack.

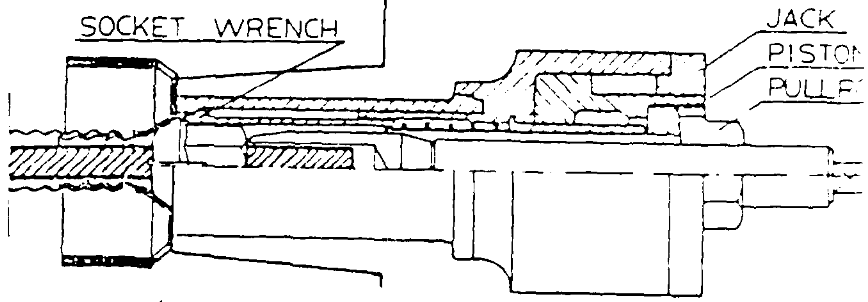
Set counter to zero and do not touch it again until the bar is totally stressed

Counterturns: C.T.

1"ø bar: 1C.T.=0.51"

1¼"ø bar: 1C.T.=0.667"

1⅜"ø bar: 1C.T.=0.709"

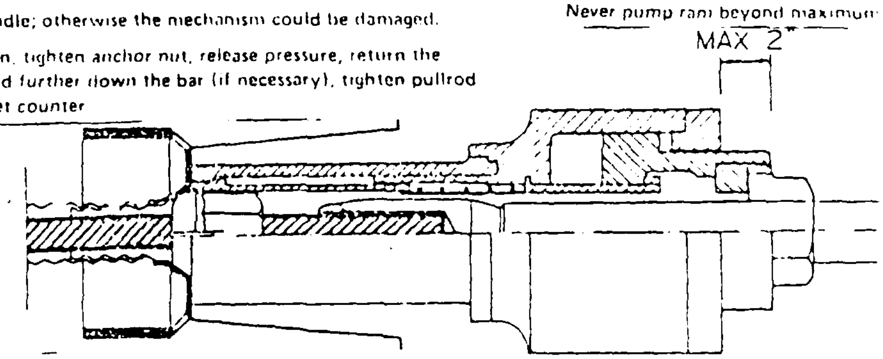


Do not in any case, stand behind the jack during stressing procedures.

Do not use any extension on the ratchet handle; otherwise the mechanism could be damaged.

In case of running out of stroke of the piston, tighten anchor nut, release pressure, return the piston to fully closed position. Screw pullrod further down the bar (if necessary), tighten pullrod nut and then continue stressing. Do not reset counter

Never pump ram beyond maximum



When overstress force and specified counterturns are reached, record readings on the stressing records.

Release pressure

Make lift off reading

Note lift off gauge pressure on the stressing records

Release pressure, retract piston, but do not exceed 1000 psi gauge pressure

Remove jack and pullrod

Measure bar extension after stressing and record. Compare elongation (= difference between bar extension before and after stressing), with counterturns reached and with specified elongation.

OPERATING INSTRUCTIONS

for the 60-Mp Jack, Series 04

Technical Data of the equipment

Area "Tensioning"	20.5 in^2
Area "Return Motion"	9.9 in^2
Maximum working pressure	8100 psi
Maximum return motion pressure	1000 psi
Maximum piston power, making allowance for the friction	160 Kip
Stroke	2 in.
Weight (without pullrod)	80 lbs.

Note: The anchor nut can travel during stressing 2 in. inside the jack.

Friction loss in the jack at	1400 psi	=	18.8%
	2800 psi	=	10 %
	4300 psi	=	8.2%
	5000 psi	=	7.5%
	5700 psi	=	6.9%
	6400 psi	=	6.2%
	7100 psi	=	5.7%

In the range between 3500 and 8000 psi a constant friction loss of 7.7 Kip or 375 psi can be assumed.

NOTE: This friction loss table will be superseded in case a special calibration charge is provided with the jack.

"Q"

MODIFICATIONS

(Relative To Foundation Report)

Mod. No.	Date	Description	Page
P00005	31 Jan 84	"VE" Redesign of D/S Cofferdam	[illegible]
P00023	25 Jun 86	"H" Road Tie-In	9-4
P00026	11 Aug 86	Service Road - Right Abutment	9-5
P00027	17 Sep 86	"VE" Redesign Stage II Diversion System	[illegible]
P00033	02 Mar 87	Survey & Sample for Trash Boom . . .	[illegible]
P00036	03 Mar 87	Miscellaneous Changes	9-1[illegible]
P00048	31 Mar 87	Drain Hole Extension	9-14
P00052	Pending	Monolith 12: Exploratory - Dia. Core Borings	

STANDARD FORM 30, JULY 1966
GENERAL SERVICES ADMINISTRATION
FED. PROC. REG. (41 CFR) 1-16.101

AMENDMENT OF SOLICITATION/MODIFICATION OF CONTRACT

PAGE 1 OF 2

1. AMENDMENT/MODIFICATION NO. P00005
2. EFFECTIVE DATE 84JAN13
3. REQUISITION/PURCHASE REQUEST NO.
4. PROJECT NO. (If applicable) SWJ

5. ISSUED BY CODE A2706B
Department of the Army
Huntington District Corps of Engineers
502 Eighth Street
Huntington, WV 25701
BUYER/SYMBOL
MRS.SWAN/ORHSU-C
Phone: 304-529-5688

6. ADMINISTERED BY (If other than block 5) CODE

7. CONTRACTOR NAME AND ADDRESS CODE FACILITY CODE
(Street, city, county, state, and ZIP Code)
The J. F. Allen Company and
Wiley N. Jackson Company, Joint Venture
PO Box 49
Clarksburg, WV 26301

8.
☐ AMENDMENT OF SOLICITATION NO.
DATED (See block 9)
☒ MODIFICATION OF CONTRACT/ORDER NO. DACW59-83-C-0053
DATED 83 Jul 29 (See block 11)

9. THIS BLOCK APPLIES ONLY TO AMENDMENTS OF SOLICITATIONS

☐ The above numbered solicitation is amended as set forth in block 12. The hour and date specified for receipt of Offers ☐ is extended, ☐ is not extended.

Offerors must acknowledge receipt of this amendment prior to the hour and date specified in the solicitation, or as amended, by one of the following methods:

(a) By signing and returning ____ copies of this amendment; (b) By acknowledging receipt of this amendment on each copy of the offer submitted; or (c) By separate letter or telegram which includes a reference to the solicitation and amendment numbers. FAILURE OF YOUR ACKNOWLEDGMENT TO BE RECEIVED AT THE ISSUING OFFICE PRIOR TO THE HOUR AND DATE SPECIFIED MAY RESULT IN REJECTION OF YOUR OFFER. If, by virtue of this amendment you desire to change an offer already submitted, such change may be made by telegram or letter, provided such telegram or letter makes reference to the solicitation and this amendment, and is received prior to the opening hour and date specified.

10. ACCOUNTING AND APPROPRIATION DATA (If required)

Approved by Office of Counsel on 17 Jan 84 by

Reviewed by Audit 1/11/84 Date Int.

11. THIS BLOCK APPLIES ONLY TO MODIFICATIONS OF CONTRACTS/ORDERS

(a) ☒ This Change Order is issued pursuant to General Provision 3 and 56 of the contract.
The Changes set forth in block 12 are made to the above numbered contract/order.

(b) ☐ The above numbered contract/order is modified to reflect the administrative changes (such as changes in paying office, appropriation data, etc.) set forth in block 12.

(c) ☐ This Supplemental Agreement is entered into pursuant to authority of
It modifies the above numbered contract as set forth in block 12.

12. DESCRIPTION OF AMENDMENT/MODIFICATION

Reference is made to General Provision 3, "Changes," and General Provision 56, "Value Engineering Incentive," of the above numbered contract for Construction of Dam, Stonewall Jackson Lake, West Fork River, West Virginia.

Since the Contractor has submitted a value engineering proposal to reduce the cost of construction by utilizing three 84-Inch reinforced concrete pipe in place of the original designed concrete cofferdam floodway bridge and since it has been determined to be in the best interest of the Government to adopt the Contractor's proposal and apply it to the contract, it is necessary to modify the contract in certain particulars as set forth below.

The VE proposal for use of three (3) Reinforced Concrete Pipe culverts as alternate for the lower dike bridge shown on the contract drawings No. 032-U1-19/1 and 19/5 is hereby approved subject to the following and as directed in the field by the Contracting Officer.

1. Scour protection (grouted riprap) shall be provided on both upstream and downstream embankment faces for the full width of the over floor area.

2. The 8-inch walls at both ends of the pipes shall be placed together with the 6-inch concrete slab and reinforcing provided for tying the units together.

Except as provided herein, all terms and conditions of the document referenced in block 8, as heretofore changed, remain unchanged and in full force and effect.

☐ CONTRACTOR/OFFEROR IS NOT REQUIRED TO SIGN THIS DOCUMENT ☐ CONTRACTOR/OFFEROR IS REQUIRED TO SIGN THIS DOCUMENT AND RETURN ____ COPIES TO ISSUING OFFICE

NAME OF CONTRACTOR/OFFEROR The J. F. Allen Company & Wiley Jackson, A Joint Venture
(Signature of person authorized to sign)

17. UNITED STATES OF AMERICA
BY John W. Devens
(Signature of Contracting Officer)

NAME AND TITLE OF SIGNER (Type or print)
John C. Allen
JOHN C. ALLEN PRES

16. DATE SIGNED 84 JAN 23

18. NAME OF CONTRACTING OFFICER (Type or print)
JOHN W. DEVENS
Colonel, Corps of Engineers
Contracting Officer

19. DATE SIGNED 84JAN13

101-01

3. Wing walls shall be provided at either side of the 8-inch concrete wall and 6-inch slab to retain the 1 to 2 earth embankment slopes.

4. Footings are to be provided for the wingwalls.

5. High slump concrete cut-off shall be provided between the pipes up to the spring line. The cut-off shall extend from the downstream headwall to the point where the pipes are bedded in impervious fill.

All work shall be in accordance with the applicable provisions of the contract specifications and as directed in the field.

As a result of the change, two (2) new lump sum priced items will be added to the contract as follows:

Item No.	Description	Quantity	Unit	Unit Price	Amount Increase	Amount Decrease
Mod (No. P00005-1)	V.E. Cost Saving for Change in Floodway Bridge	1	Job	Sum		$ 2,926.22
Mod (No. P00005-2)	V.E. Incentive Adjustment for VE Change in Floodway Bridge	1	Job	Sum	$ 1,609.42	
			Totals		$ 1,609.42	$ 2,926.22

Due to the foregoing modification the total contract amount is decreased in the amount of (-) $1,316.80.

The time for completion of performance under the contract will remain unchanged.

If the foregoing modification is acceptable it is requested that you sign in Block 14, complete Blocks 15 and 16 of the form, and return the original to this office (Attention: ORHSU).

SWJ

AMENDMENT OF SOLICITATION/MODIFICATION OF CONTRACT

1. CONTRACT ID CODE

PAGE OF PAGES 1 2

AMENDMENT/MODIFICATION NO.	3. EFFECTIVE DATE	4. REQUISITION/PURCHASE REQ. NO.	5. PROJECT NO. (If applicable)
P00023	86JUN23		

ISSUED BY CODE A2706B BUYER/SYMBOL
Department of the Army
Huntington District, Corps of Engineers
502 8th Street MR. PINNICK/ORHSU-C
Huntington, West Virginia 25701-2070
PH: 304-529-5688

7. ADMINISTERED BY (If other than Item 6) CODE

NAME AND ADDRESS OF CONTRACTOR (No., street, county, State and ZIP Code)
The J.F. Allen Company & Wiley N. Jackson Company A.J.V.
P.O. Box 49
Clarksburg, West Virginia 26301

CODE FACILITY CODE

9A. AMENDMENT OF SOLICITATION NO

9B. DATED (SEE ITEM 11)

X 10A. MODIFICATION OF CONTRACT/ORDER NO.
DACW59-83-C-0053

10B. DATED (SEE ITEM 13)
83 July 29

11. THIS ITEM ONLY APPLIES TO AMENDMENTS OF SOLICITATIONS

☐ The above numbered solicitation is amended as set forth in Item 14. The hour and date specified for receipt of Offers ☐ is extended, ☐ is not extended.

Offers must acknowledge receipt of this amendment prior to the hour and date specified in the solicitation or as amended, by one of the following methods: (a) By completing Items 8 and 15, and returning ______ copies of the amendment; (b) By acknowledging receipt of this amendment on each copy of the offer submitted; or (c) By separate letter or telegram which includes a reference to the solicitation and amendment numbers. FAILURE OF YOUR ACKNOWLEDGMENT TO BE RECEIVED AT THE PLACE DESIGNATED FOR THE RECEIPT OF OFFERS PRIOR TO THE HOUR AND DATE SPECIFIED MAY RESULT IN REJECTION OF YOUR OFFER. If by virtue of this amendment you desire to change an offer already submitted, such change may be made by telegram or letter, provided each telegram or letter makes reference to the solicitation and this amendment, and is received prior to the opening hour and date specified.

ACCOUNTING AND APPROPRIATION DATA (If required)
FSN 96461 96X3122 CG, CE MC BE SWJ 04 10B0 0000 0320 284

13. THIS ITEM APPLIES ONLY TO MODIFICATIONS OF CONTRACTS/ORDERS, IT MODIFIES THE CONTRACT/ORDER NO. AS DESCRIBED IN ITEM 14.

A. THIS CHANGE ORDER IS ISSUED PURSUANT TO: (Specify authority) THE CHANGES SET FORTH IN ITEM 14 ARE MADE IN THE CONTRACT ORDER NO. IN ITEM 10A.

B. THE ABOVE NUMBERED CONTRACT/ORDER IS MODIFIED TO REFLECT THE ADMINISTRATIVE CHANGES (such as changes in paying office, appropriation date, etc.) SET FORTH IN ITEM 14, PURSUANT TO THE AUTHORITY OF FAR 43.103(b).

X C. THIS SUPPLEMENTAL AGREEMENT IS ENTERED INTO PURSUANT TO AUTHORITY OF:
General Provision 3 "Changes"

D. OTHER (Specify type of modification and authority)

IMPORTANT: Contractor ☐ is not, ☒ is required to sign this document and return one copies to the issuing office

DESCRIPTION OF AMENDMENT/MODIFICATION (Organized by UCF section headings, including solicitation/contract subject matter where feasible.)

Reference is made to General Provision 3, "Changes" of the above numbered contract for Construction of Dam, Stonewall Jackson Lake, West Fork River, West Virginia.

It has been determined to be necessary and in the best interest of the Government to modify the above contract in certain particulars as follows:

The Contractor shall furnish all plant, labor, material and equipment necessary to build a tie-in road from the future dam-turnaround on the left abutment to the existing "H" oil and gas-access road.

Except as provided herein, all terms and conditions of the document referenced in Item 9A or 10A, as heretofore changed, remains unchanged and in full force and effect.

15A. NAME AND TITLE OF SIGNER (Type or print)		16A. NAME AND TITLE OF CONTRACTING OFFICER (Type or print)	
		ROBERT B. WILSON, COL, Corps of Engineers Contracting Officer	
15B. CONTRACTOR/OFFEROR	15C. DATE SIGNED	16B. UNITED STATES OF AMERICA	16C. DATE SIGNED
(Signature of person authorized to sign)		BY (Signature of Contracting Officer)	86JUN23

The tie-in road shall consist of an approximate 550 foot length of 12 foot wide stone surface and shall include the required excavation and embankment work, stone surface, two 18-inch CMP culverts with drop inlets, stone paved gutter, guard rail, and required seeding. Unclassified excavation shall be performed in accordance with Section 207 of the West Virginia Highway Specifications, Class 8 Aggregate shall be furnished and applied in accordance with Section 808 of the West Virginia Highway Specifications, and the Type "G" Inlets shall be constructed in accordance with Section 605 of the West Virginia Highway Specifications. Other work shall be performed in accordance with the applicable contract specifications. All work shall be constructed as shown on revised Contract Drawing 037d-U1-0/1.3, 037d-U1-4/1.1, and 037d-U1-12/27 and new Contract Drawing 037d-U1-12/83 which have been previously furnished.

As a result of the foregoing, one new lump sum payment item shall be added to the contract as follows:

Item No.	Description	Quantity	Unit	Unit Price	Amount
New P00023-1	"H" Road Tie-In	1	Job	Sum	$88,000.00

As a result of the foregoing the Contract Price shall be increased by $88,000.00.

The contract time shall remain unchanged.

It is understood and agreed that the adjustment provided herein constitutes compensation in full on behalf of the Contractor, his subcontractors and suppliers, for all costs and mark-up directly or indirectly attributable to the change ordered, for all delays and impacts related thereto, and for performance of the change within the time frame stated.

If the foregoing modification is acceptable, it is requested that you sign in Block 15B, complete blocks 15A and 15C of the form, and return the original to this office (ATTN: ORHSU) after the Consent of Surety has been executed by you and your surety.

N

AMENDMENT OF SOLICITATION/MODIFICATION OF CONTRACT

1. CONTRACT ID CODE	PAGE OF PAGES
	1 of 2

2. AMENDMENT/MODIFICATION NO.	3. EFFECTIVE DATE	4. REQUISITION/PURCHASE REQ. NO.	5. PROJECT NO. (If applicable)
P00026	86AUG11		

6. ISSUED BY CODE A2706B

Department of the Army BUYER/SYMBOL
Huntington District, Corps of Engineers
502 8th Street MR. PINNICK/ORHSU-C
Huntington, West Virginia 25701-2070
PH: 304-529-5688

7. ADMINISTERED BY (If other than Item 6) CODE

H H2<

8. NAME AND ADDRESS OF CONTRACTOR (No., street, county, State and ZIP Code)

The J.F. Allen Company & Wiley N. Jackson Company
P.O. Box 49
Clarksburg, West Virginia 26301

CODE FACILITY CODE

(✓) 9A. AMENDMENT OF SOLICITATION NO.

9B. DATED (SEE ITEM 11)

X 10A. MODIFICATION OF CONTRACT/ORDER NO. DACW59-83-C-0053

10B. DATED (SEE ITEM 13) 83 July 29

11. THIS ITEM ONLY APPLIES TO AMENDMENTS OF SOLICITATIONS

☐ The above numbered solicitation is amended as set forth in Item 14. The hour and date specified for receipt of Offers ☐ is extended, ☐ is not extended.

Offers must acknowledge receipt of this amendment prior to the hour and date specified in the solicitation or as amended, by one of the following methods: (a) By completing Items 8 and 15, and returning ______ copies of the amendment; (b) By acknowledging receipt of this amendment on each copy of the offer submitted; or (c) By separate letter or telegram which includes a reference to the solicitation and amendment numbers. FAILURE OF YOUR ACKNOWLEDGMENT TO BE RECEIVED AT THE PLACE DESIGNATED FOR THE RECEIPT OF OFFERS PRIOR TO THE HOUR AND DATE SPECIFIED MAY RESULT IN REJECTION OF YOUR OFFER. If by virtue of this amendment you desire to change an offer already submitted, such change may be made by telegram or letter, provided each telegram or letter makes reference to the solicitation and this amendment, and is received prior to the opening hour and date specified.

12. ACCOUNTING AND APPROPRIATION DATA (If required)

FSN 96461 96X3122 CG, CE MC BE SWJ 04 10B0 0000 0320 284

13. THIS ITEM APPLIES ONLY TO MODIFICATIONS OF CONTRACTS/ORDERS, IT MODIFIES THE CONTRACT/ORDER NO. AS DESCRIBED IN ITEM 14.

(✓)	
X	A. THIS CHANGE ORDER IS ISSUED PURSUANT TO: (Specify authority) THE CHANGES SET FORTH IN ITEM 14 ARE MADE IN THE CONTRACT ORDER NO. IN ITEM 10A. General Provision 3 "Changes"
	B. THE ABOVE NUMBERED CONTRACT/ORDER IS MODIFIED TO REFLECT THE ADMINISTRATIVE CHANGES (such as changes in paying office, appropriation date, etc.) SET FORTH IN ITEM 14, PURSUANT TO THE AUTHORITY OF FAR 43.103(b).
	C. THIS SUPPLEMENTAL AGREEMENT IS ENTERED INTO PURSUANT TO AUTHORITY OF:
	D. OTHER (Specify type of modification and authority)

E. IMPORTANT: Contractor ☐ is not, ☒ is required to sign this document and return one copies to the issuing office.

14. DESCRIPTION OF AMENDMENT/MODIFICATION (Organized by UCF section headings, including solicitation/contract subject matter where feasible.)

Reference is made to General Provision 3, "Changes" of the above numbered contract for Construction of Dam, Stonewall Jackson Lake, West Fork River, West Virginia.

Contractor shall furnish all plant, labor, materials and equipment necessary to modify the service road at the right abutment as follows:

a. Move the centerline five feet into the right hillside.

b. Construct a 32-foot cribwall to support the roadway and bank.

Except as provided herein, all terms and conditions of the document referenced in Item 9A or 10A, as heretofore changed, remains unchanged and in full force and effect.

15A. NAME AND TITLE OF SIGNER (Type or print)		16A. NAME AND TITLE OF CONTRACTING OFFICER (Type or print)	
		ROBERT B. WILSON, COL, Corps of Engineers Contracting Officer	
15B. CONTRACTOR/OFFEROR	15C. DATE SIGNED	16B. UNITED STATES OF AMERICA	16C. DATE SIGNED
(Signature of person authorized to sign)		BY [signature] (Signature of Contracting Officer)	86AUG11

NSN 7540-01-152-8070
PREVIOUS EDITION UNUSABLE

STANDARD FORM 30 (REV. 10-83)
Prescribed by GSA
FAR (48 CFR) 53.243

c. Install a drop inlet at Station 0+60.

All work shall be accomplished as shown on revised drawings 037d-U1-12/29.2 and 037d-U1-100/4. The cribwall shall be constructed in accordance with the attached specification. The drop inlet frame and grating shall be similar and equal to Allegheny Foundry Patterns 770 and 771.

As a result of this change, one (1) new lump sum item will be added to the contract as follows:

Item No.	Description	Quantity	Unit	Unit Price	Amount
New (Mod P00026)	Move Service Road Centerline 5 feet	1	Job	Sum	$76,000.00
		Lump Sum Increase			$76,000.00

As a result of this modification the contract price will be increased by the amount of $76,000.00.

The contract performance time shall remains unchanged.

It is understood and agreed that the adjustment provided herein shall constitute full and complete compensation on behalf of the Contractor, his subcontractors and suppliers, for all costs and mark-up directly or indirectly attributed to the change ordered, for all delays related thereto, and for performance of the work within the time frame stated.

If the foregoing modification is acceptable, it is requested that you sign in Block 15B, complete blocks 15A and 15C of the form, and return the original to this office (ATTN: ORHSU) after the Consent of Surety has been executed by you and your surety.

AMENDMENT OF SOLICITATION/MODIFICATION OF CONTRACT

1. CONTRACT ID CODE	
PAGE 1	OF PAGES 2

AMENDMENT/MODIFICATION NO. P00027

3. EFFECTIVE DATE

4. REQUISITION/PURCHASE REQ. NO.

5. PROJECT NO. (If applicable)

ISSUED BY CODE A2706B

BUYER/SYMBOL
MR. PINNICK/ORHSU
PH: 304,529-5688

...tir ...n District
...S. Army Corps of Engineers
... Eighth Street
...tington, West Virginia 25701-2070

7. ADMINISTERED BY (If other than Item 6) CODE

NAME AND ADDRESS OF CONTRACTOR (No., street, county, State and ZIP Code)

...J.F. Allen Company and Wiley N. Jackson Company
...oint Venture
... Box 49
...rksburg, WV 26301

9A. AMENDMENT OF SOLICITATION NO.

9B. DATED (SEE ITEM 11)

X 10A. MODIFICATION OF CONTRACT/ORDER NO. DACW59-83-C-0053

10B. DATED (SEE ITEM 13) 83 July 29

...E | FACILITY CODE

11. THIS ITEM ONLY APPLIES TO AMENDMENTS OF SOLICITATIONS

The above numbered solicitation is amended as set forth in Item 14. The hour and date specified for receipt of Offers ☐ is extended, ☐ is not extended.
...s must acknowledge receipt of this amendment prior to the hour and date specified in the solicitation or as amended, by one of the following methods:
...y completing Items 8 and 15, and returning ______ copies of the amendment; (b) By acknowledging receipt of this amendment on each copy of the offer ...itted; or (c) By separate letter or telegram which includes a reference to the solicitation and amendment numbers. FAILURE OF YOUR ACKNOWLEDG...T TO BE RECEIVED AT THE PLACE DESIGNATED FOR THE RECEIPT OF OFFERS PRIOR TO THE HOUR AND DATE SPECIFIED MAY RESULT ...EJECTION OF YOUR OFFER. If by virtue of this amendment you desire to change an offer already submitted, such change may be made by telegram or ... provided each telegram or letter makes reference to the solicitation and this amendment, and is received prior to the opening hour and date specified.

...CCOUNTING AND APPROPRIATION DATA (If required)
96461 96X3122 CG,CE MC BE SWJ 04 10B0 0000 0320 284

13. THIS ITEM APPLIES ONLY TO MODIFICATIONS OF CONTRACTS/ORDERS, IT MODIFIES THE CONTRACT/ORDER NO. AS DESCRIBED IN ITEM 14.

A. THIS CHANGE ORDER IS ISSUED PURSUANT TO: (Specify authority) THE CHANGES SET FORTH IN ITEM 14 ARE MADE IN THE CONTRACT ORDER NO. IN ITEM 10A.

B. THE ABOVE NUMBERED CONTRACT/ORDER IS MODIFIED TO REFLECT THE ADMINISTRATIVE CHANGES (such as changes in paying office, appropriation date, etc.) SET FORTH IN ITEM 14, PURSUANT TO THE AUTHORITY OF FAR 43.103(b).

C. THIS SUPPLEMENTAL AGREEMENT IS ENTERED INTO PURSUANT TO AUTHORITY OF:
General Provisions 3 "Changes" and General Provisions 56 "Value Engineering Incentive-Construction"

D. OTHER (Specify type of modification and authority)

...PORTANT: Contractor ☐ is not, ☒ is required to sign this document and return one copies to the issuing office.

...SCRIPTION OF AMENDMENT/MODIFICATION (Organized by UCF section headings, including solicitation/contract subject matter where feasible.)

...rence is made to General Provision 3 "Changes" and General Provision 56 "Value ...neering Incentive-Construction" of the above numbered contract for Construction of Stonewall Jackson Lake, West Fork River, West Virginia.

...oposal for revising the Stage II Diversion Scheme has been submitted and approved ...r the Value Engineering Incentive Clause of the contract.

...s therefore in the best interest of the Government to modify the contract in certain ...iculars as follows:

...as provided herein, all terms and conditions of the document referenced in Item 9A or 10A, as heretofore changed, remains unchanged and in full force ...ect.

...AME AND TITLE OF SIGNER (Type or print)

16A. NAME AND TITLE OF CONTRACTING OFFICER (Type or print)
ROBERT D. BROWN III, COL, Corps of Engineers
Contracting Officer

...NTRA... R/OFFEROR ______ (Signature of person authorized to sign) | 15C. DATE SIGNED

16B. UNITED STATES OF AMERICA BY (Signature of Contracting Officer)

16C. DATE SIGNED 19 Sept 86

...40-01-152-8070 ...OUS EDITION UNUSABLE

30-105

(Q-8)

STANDARD FORM 30 (REV. 10-83)
Prescribed by GSA
FAR (48 CFR) 53.243

"Modify the Stage II Diversion scheme by excavating a diversion channel along the base of the right abutment and diverting flow through partially completed Monolith No. 4. Concrete for Monolith No. 4 shall be placed to elevation 1012.5. The Stage I upstream coffer dike shall be extended to tie into the left abutment and plug the Stage I diversion channel. All Stage II steel sheet pile cofferdam cells shall be eliminated. Prior to Stage II diversion, Monolith No's 1 through 9 except Monolith No. 4 shall be constructed to a minimum elevation of 1060, including all gates, embedded items, and related appurtenances. The stilling basin shall be complete, ready to accept flow."

All work shall be accomplished in accordance with applicable contract documents, the approved Value Engineering proposal, and as directed by the Contracting Officer.

Credit for New Item (New Mod P00027-1) Diversion Scheme" "V.E. Revised Stage II" shall provide for all cost reductions resulting from the revised Stage II Diversion Scheme. The adjustment along with payment under Bid Item No. 4, "Cofferdams and Diversion and Care of Water" which shall include payment for the common and rock excavation and presplitting work associated with diversion work and cofferdam removal, shall constitute full and complete payment for all work outlined under contract Section 2C "Cofferdams and Diversion and Care of Water". "V.E. Incentive Adjustment of Item (New Mod P00027-1)" shall provide the Contractor's share of savings in accordance with the Value Engineering Clauses of the contract.

As a result of the change, two (2) new unit priced items will be added to the contract as follows:

Item No.	Description	Estimated Quantity	Unit	Estimated Amount Increase	Estimated Amount Decrease
(New Mod P00027-1)	V.E. Revised Stage II Diversion Scheme	1	Job		$45,000.00
(New Mod P00027-2)	V.E. Incentive Adjustment of Item (New Mod P00027-1)	1	Job	$24,750.00	
				Net Decrease	$20,250.00

The total contract amount is decreased in the amount of $20,250.00.

The contract performance time shall remain unchanged.

If the foregoing modification is acceptable, it is requested that you sign in Block 15B, complete blocks 15A and 15C of the form, and return the original to this office (ATTN: ORHSU).

CONTRACT MODIFICATION PROPOSAL AND ACCEPTANCE
(Modification of less than $50,000)
For use of this form, see ER 1180-1-1.

1. ISSUING OFFICE	2. CONTRACT NO.	3. MODIFICATION NO.
U.S. Army Engineer District, Huntington Stonewall Jackson Lake Project	DACW59-83-C-0053	P00033

4. TO (Contractor)	5. PROJECT LOCATION AND DESCRIPTION
J.F. Allen Co. & Wiley N. Jackson, AJV P.O. Box 49 Clarksburg, WV 26301	Construction of Stonewall Jackson Dam, West Fork River, West Virginia

6. *A proposal is requested for making the hereinafter described change in accordance with specification and drawing revisions cited herein or listed in attachment hereto. Submit your proposal in space indicated on page 2, attach detailed breakdown of prime and subcontract costs. (See the clause of this contract entitled, "Modification Proposals - Price Breakdown") DO NOT start work under this proposed change until you receive a copy signed by the Contracting Officer or a directive to proceed.*

RONALD C. HARRIS
Resident Contracting Officer

Date | Typed Name and Title | Signature

7. DESCRIPTION OF CHANGE: *Pursuant to the clause of this contract entitled, "Changes", the contractor shall furnish all plant, labor and material, and perform all work necessary to accomplish the following described work:*

1. Survey and locate the trash boom anchorage sites at N 729,230 E 2,149, 270 and at N 729,680 E2,148,620.

2. Provide all necessary equipment, labor and materials to construct access to the trash boom anchorage sites and perform foundation samplings as outlined below:

   a. N 729,230 E2,149,270: 20 foot depth with split-spoon sampling to rock.

   b. N 729,680 E2,148,620: 30 foot depth with only coring required.

3. All work shall be accomplished in accordance with the applicable contract provisions and as directed by the Resident Engineer.

4. The above modification will result in the addition of two new items of work to the contract for which payment will be made at the agreed lump sum prices hereby established as follows:

Except as hereby Modified, all terms and conditions of said contract as heretofore Modified remain unchanged and in full force and effect.

The foregoing modification is hereby accepted:	UNITED STATES OF AMERICA
CONTRACTOR J.F. Allen Co. & Wiley N. Jackson Co.	RONALD C. HARRIS Resident Contracting Officer
BY Lou Hutcherson Signature	Ronald C Harris Signature
March 2, 1987 — LOU HUTCHERSON/Proj. Mgr. Date — Typed Name and Title	02 MAR 1987 Date — Typed Name and Title

ENG FORM 3938, Jul 81 EDITION OF JUN 77 IS OBSOLETE. PAGE 1 OF 2 PAGES

Item	Description	Quantity	Unit	Unit Price	Amount
P00033-1	Trash Boom Anchor Layout	1	Job	Sum	$ 910.48
P00033-2	Trash Boom Core Samplings and Access Road	1	Job	Sum	$10,199.16
				NET INCREASE	$11,109.64

5. The total contract price is increased in the amount of $11,109.64.

6. The contract time shall be unchanged.

9. This adjustment constitutes compensation in full on behalf of the Contractor and its subcontractors and suppliers, for all costs and markups directly or indirectly attributable to the change ordered herein, including impact, for all unchanged work, for all delays related thereto, and for performance of the change within the timeframe stated.

CONTRACT MODIFICATION PROPOSAL AND ACCEPTANCE
(Modification of less than $50,000)
For use of this form, see ER 1180-1-1.

1. ISSUING OFFICE	2. CONTRACT NO.	3. MODIFICATION NO.
U.S. Army Engineer District, Huntington Stonewall Jackson Lake Project	DACW59-83-C-0053	P00036

4. TO (Contractor)	5. PROJECT LOCATION AND DESCRIPTION
J.F. Allen Co. & Wiley N. Jackson, AJV P.O. Box 49 Clarksburg, WV 26301	Construction of Stonewall Jackson Dam, West Fork River, West Virginia

6. A proposal is requested for making the hereinafter described change in accordance with specification and drawing revisions cited herein or listed in attachment hereto. Submit your proposal in space indicated on page 2, attach detailed breakdown of prime and subcontract costs. (See the clause of this contract entitled, "Modification Proposals - Price Breakdown") DO NOT start work under this proposed change until you receive a copy signed by the Contracting Officer or a directive to proceed.

RONALD C. HARRIS
Resident Contracting Officer

Date — Typed Name and Title — Signature

7. DESCRIPTION OF CHANGE: *Pursuant to the clause of this contract entitled, "Changes", the contractor shall furnish all plant, labor and material, and perform all work necessary to accomplish the following described work:*

1. Construct access to the "H" road site and perform core drilling and split-tube sampling of soil and rock conditions along the proposed "H" road alignment. The drilling and sampling will be done at the nine (9) locations shown on the previously provided boring plan titled "H Road Tie-In," and in accordance with the Resident Engineer's guidance.

2. Change the one-inch spacer blocks to one-half-inch spacer blocks on the water quality control gates, and weld shut the drain holes on the same gates. These items are indicated on Contract Drawing No. 037d-U1-62/7 and specifically indicated by the Resident Engineer in the field.

3. Completely seal eight (8) drain holes with concrete on the roadway parapet wall (upstream side) above the quality control tower steps and electrical switch equipment. The holes will be specifically indicated by the Resident Engineer.

4. Survey and monitor the alignment and reference monuments above the access road on the left abutment of the dam. Monument locations and frequency of the monitoring to be per the Resident Engineer's guidance in the field.

5. Replace the two (2) doors to the Water Quality Control Tower Hydraulic Pump Room with two T63815 47-1/2" x 47-1/2" x 1-1/2" aluminum louvered doors, or suitable equivalent, and eight aluminum covers for the soil and sanitary sewer lines located in the stairways of the control tower. All items to be installed per the Resident Engineer's guidance.

6. Construct a sample block of Ready-mix concrete 48" x 48" x 48". All work will be in accordance with the Resident Engineer's guidance.

Except as hereby Modified, all terms and conditions of said contract as heretofore Modified remain unchanged and in full force and effect.

The foregoing modification is hereby accepted:	UNITED STATES OF AMERICA
CONTRACTOR J.F. Allen Co. and Wiley N. Jackson Co. Lou Hutcherson Signature	Ronald C. Harris Signature
3-3-87 LOU HUTCHERSON/Proj. Mgr. Date — Typed Name and Title	RONALD C. HARRIS Resident Contracting Officer 03 MAR 1987 Date — Typed Name and Title

7. Remove and replace the bearing plates on the bottom of the water quality control gates to ensure proper compression of the seals on the gates. Work to be done in accordance with the Resident Engineer's guidance.

8. All work shall be accomplished in accordance with applicable contract provisions and as directed by the Resident Engineer.

9. The above modification will result in the addition of seven new items of work to the contract for which payment will be made at the agreed lump sum prices hereby established as indicated below:

Item	Description	Quantity	Unit	Unit Price	Amount
P00036-1	2-Inch Core Holes	1	Job	Sum	$9,773.08
P00036-2	Spacer Blocks & Drain Holes	1	Job	Sum	1,132.71
P00036-3	Parapet Wall Drain Holes	1	Job	Sum	527.25
P00036-4	Monitoring Slip	1	Job	Sum	728.23
P00036-5	Pump Room Doors in WOCT	1	Job	Sum	791.80
P00036-6	Sample Concrete Block Form	1	Job	Sum	1,714.38
P00036-7	Bearing Plates on WOCT	1	Job	Sum	481.33
				NET INCREASE	$15,148.78

10. The total contract price is increased in the amount of $15,148.78.

11. The contract completion date remains unchanged.

12. This adjustment constitutes compensation in full on behalf of the Contractor and its subcontractors and suppliers, for all costs and markups directly or indirectly attributable to the change ordered including impact, for all delays related thereto, and for performance of the change within the time frame stated.

CONTRACT MODIFICATION PROPOSAL AND ACCEPTANCE
(Modification of less than $50,000)
For use of this form, see ER 1180-1-1.

1. ISSUING OFFICE	2. CONTRACT NO.	3. MODIFICATION NO.
US Army Engineer District, Huntington Stonewall Jackson Lake Project	DACW59-83-C-0053	P00048

4. TO (Contractor)	5. PROJECT LOCATION AND DESCRIPTION
J.F. Allen Co. & Wiley N. Jackson, AJV P.O. Box 49 Clarksburg, West Virginia 26301	Construction of Stonewall Jackson Dam West Fork River, West Virginia

6. *A proposal is requested for making the hereinafter described change in accordance with specification and drawing revisions cited herein or listed in attachment hereto. Submit your proposal in space indicated on page 2, attach detailed breakdown of prime and subcontract costs. (See the clause of this contract entitled, "Modification Proposals - Price Breakdown") DO NOT start work under this proposed change until you receive a copy signed by the Contracting Officer or a directive to proceed.*

02-21-87

02-11-87 — RONALD C. HARRIS, Resident Contracting Officer — Ronald C Harris

Date — Typed Name and Title — Signature

7. DESCRIPTION OF CHANGE: *Pursuant to the clause of this contract entitled, "Changes", the contractor shall furnish all plant, labor and material, and perform all work necessary to accomplish the following described work:*

1. Extend the 62 foundation drain holes piping 6 inches into the gutter. This shall be accomplished by adding a 4" diameter X 6" long nipple. Where the existing couplings are too close the gutter floor (holes 11, 12, 17 and 18) a 4"x1½" reducer and a 1½" diameter X 6" long nipple shall be used.

2. All pipe and fittings shall be galvanized and nipples shall be threaded on both ends.

3. All work shall be accomplished in accordance with applicable contract requirements and as directed by the Resident Engineer.

4. As a result of the above modification one new item of work is added to the contract for which payment will be made at the lump sum price hereby established as indicated below:

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	AMOUNT
P00048-1	Foundation Drain Holes Extensions	1	Job	SUM	$1,986.68

5. The total contract is increased in the lump sum amount of $1,986.68

6. The contract time remains unchanged.

7. This adjustment constitutes compensation in full on behalf of the contractor and its subcontractors and suppliers for all costs and markups directly or indirectly

Cont'd on Pg. 2

Except as hereby Modified, all terms and conditions of said contract as heretofore Modified remain unchanged and in full force and effect.

The foregoing modification is hereby accepted:

CONTRACTOR

J.F. ALLEN CO. AND WILEY N. JACKSON CO.

BY Lou Hutcherson
Signature

LOU HUTCHERSON
PROJECT MANAGER

3-31-87
Date — Typed Name and Title

UNITED STATES OF AMERICA

Ronald C Harris
Signature

RONALD C. HARRIS
03-31-87 Resident Contracting Officer
Date — Typed Name and Title

Contract No. DACW59-83-C-0053
Modification No. P00048
Stonewall Jackson Lake Project

attributable to the change ordered herein, for all unchanged work, for all delays related thereto and for performance of the changes within the time frame stated.

8. Applicable Accounting Classification: MC BE SWJ 04 10B0 0000 0320 284 FSN 96461.

"R"

CORRESPONDENCE

LETTERS

Date	Subject	PAGE
02 Sep 83	Notice of contract award	R-[illegible]
1[illegible] Aug 83	Diversion channel rock bolt test	R-4
2[illegible] Sep 83	Rock bolt installation	R-6
[illegible] Sep [illegible]	Diversion channel rock anchors	R-8
0[illegible] Mar 83	Monolith foundation preparation	R-11
04 Jan 84	Blasting schedule	R-12
2[illegible] Feb 84	Rock bolt installation	R-1[illegible]
2[illegible] Feb [illegible]	Drilling and blasting revision	R-1[illegible]
0[illegible] May [illegible]	[illegible]" Diameter exploratory drilling ...	R-2[illegible]
[illegible] Sep 85	River diversion	R-2[illegible]
[illegible] Feb 86	Curtain grouting revision	R-2[illegible]
14 May 86	Curtain grouting revision	R-2[illegible]
30 Dec 86	Beneficial occupancy	R-31

MEMO FOR RECORD - Field Trips

Date	From	Subject	
0[illegible] Nov 83	ORPED-G	Cofferdam design	R-32
05 Mar 84	ORPED-G	Field trip report	R-33
14 Mar 84	ORDED-G	Foundation grades	R-[illegible]
15 Mar 84	ORPED-G	Foundation grades	R-[illegible]
[illegible] Mar [illegible]	ORPED-G	Examine core	R-[illegible]
05 Apr 84	ORPED-G	Examine core	R-46
1[illegible] Apr 84	ORPED-G	Foundation grades	R-4[illegible]
11 May 84	ORPED-G	Foundation inspection ...	R-5[illegible]
2[illegible] May 84	ORPED-G	Left abutment stability..	R-5[illegible]
11 Jun 84	ORPED-G	Foundation inspection ...	R-5[illegible]
11 Jun 84	ORDED-G	Foundation grades	R-60
12 Jun 84	ORPED-G	Foundation grades	R-64
1[illegible] Jun 84	ORPED-G	Field trip report	R-6[illegible]
2[illegible] Jun 84	ORPED-G	Foundation inspection ...	R-6[illegible]
05 Sep 84	ORDED-G	Foundation grades	R-6[illegible]
12 Sep 84	ORPED-G	Foundation grades	R-[illegible]4
14 Sep 84	ORPED-G	Foundation inspection ...	R-[illegible]
06 Sep 84	ORPED-G	Foundation inspection ...	R-[illegible]
05 Dec 84	ORPED-G	Foundation grades	R-[illegible]
25 Mar 85	ORPED-G	Field trip	R-[illegible]
1[illegible] Apr 85	ORPED-G	Monolith 11/12 excavation	R-[illegible]
2[illegible] Apr 85	ORPED-G	Monolith 11/12 excavation	R-[illegible]
2[illegible] Apr 85	ORHED	Quarry operations	R-[illegible]
[illegible] May 85	ORPED-	Stage II excavation	R-[illegible]
[illegible] May [illegible]	ORPEDG	Fault zone excavation ...	R-[illegible]5
1[illegible] Jun [illegible]	ORPED-G	Foundation inspection ...	R-[illegible]

18 Jul 85	ORPED-G	Foundation inspection ... R-[illegible]
29 Jul 85	ORPED-G	Foundation inspection ... R-100
10 Oct 85	ORPED-G	Foundation inspection ... R-101
30 Dec 85	Project	Foundation grouting R-102
05 Mar 86	ORPED-G	Foundation grouting R-103
1[illegible] Apr 86	ORPED-G	Foundation grouting R-106

Mr. Cladden/mw/5280

September 2, 1983

Construction Division
Contract Administration Branch

SUBJECT: Notice of Award of Construction Contract

OFCCP-ESA-Philadelphia
U. S. Department of Labor
Gateway Building - Room 15430
3535 Market Street
Philadelphia, PA 19104

Gentlemen:

Following information is furnished relative to award of construction contract:

Name, address, and telephone number of contractor:

J. F. Allen Company and Wiley N. Jackson Company
P. O. Box 49
Clarksburg, WV 26301

Employers Identification No.: 54-0716814 & 550-328627

Dollar amount of contract: $15,985,063.75

Estimated starting and completion dates: 15 September 1983 through 15 September 1987

Contract No. DACW59-83-C-0053 for Construction of Dam, Stonewall Jackson Lake, West Fork River.

Sincerely,

ALTIZER CD-A

DAVID J. DEEDS
Chief, Construction Division

DEEDS CD

Copies furnished:
J. F. Allen Company & Wiley N. Jackson Company
P. O. Box 49
Clarksburg, WV 26301

ESA/OFCCP/Pittsburgh Area Office
Room 1626-S, Federal Building
1000 Liberty Avenue
Pittsburgh, PA 15222

ORHCD-A, wd
ORHCD-A(Cladden), wd
ORHCD-SWJ, wd
ORHCD-L, wd

Wiley N. Jackson Co.

August 18, 1983

copy

Mr. William F. Woodburn
Resident Engineer
U. S. Army Corps of Engineers
P. O. Box 608
Weston, West Virginia 26452

Re: Procedure for Rock Bolt Test Program
in the Diversion Channel Area
DACW59-83-C-0053
Stonewall Jackson Lake Dam

Dear Sir:

The following procedures will be implemented in the testing and installation of the initial ten permanent rock bolts:

1) Select two of the three areas for the test program. Choices will dictate rock bolt pattern and angle of repose.

2) Drill approximate three inch diameter hole with Joy Ram drill (model VCR260E) and Joy 850 cfm Air Compressor (model RPQ800). This hole will terminate just above the top of resin anchor region. The three inch diameter hole is necessary to accomodate bar coupling which allows for recovery of non-anchored portion of bar as required.

3) Analyze rock conditions during drilling for determination of depth and resin cartridge requirements. It is anticipated that four to six cartridges will be required.

4) Drill approximate two inch diameter hole, starting at bottom of the three inch hole, to form resin anchor area. Length may vary from five to ten feet as rock conditions dictate.

5) Place 2" diameter P.V.C. conduit into drilled hole for alignment and positive placement of resin cartridges.

6) Place Celtite resin cartridges (quantity as determined by field conditions).

7) Remove 2" diameter P.V.C. conduit.

8) Place 1 3/8" diameter, grade 150 Dywidag bar. During placement, spin bar at approximate 100 RPM, piercing resin cartridges and mixing resin components.

P.O. Box 4196 Roanoke, Virginia 24015 703-389-0251

9) Allow resin to set (approximately two minutes).

10) Place 8" x 8" x 1" bearing plate, bearing & wedge washers, anchor nut and 110 ton double acting hydraulic ram over exposed bar at rock surface. Ram will be supplied by Dywidag with a direct reading gage.

11) Tension bolt to 155,000 pounds and lock in tension.

We trust the above procedures are acceptable and in accordance with the specifications.

Yours very truly,

WILEY N. JACKSON COMPANY

Andrew M. Clark
Engineer

AMC:ig

J.F. ALLEN COMPANY AND
WILEY N. JACKSON COMPANY, JOINT VENTURE
P.O. DRAWER 747
WESTON, WV 26452

September 23, 1983

Mr. William F. Woodburn
Resident Engineer
U. S. Army Corps of Engineers
P. O. Box 608
Weston, WV 26452

ATTENTION: Mr. William F. Woodburn

RE: Procedure for Rock Bolt Installation in the Diversion Channel
Stonewall Jackson Lake Dam
DACW59-83-C-0053

Gentlemen:

Pursuant to specification 2N-3, we respectfully submit for your review the following information for installing the Rock Bolts adjacent to the Diversion Channel.

The Dywidag Rock Bolt System proved to be equal to or better from our field testing results.

PROCEDURE:

Our basic procedure consisted of 2 (two) Joy Ram Drills (Model JCR 260E) supplied by 2 (two) Joy 850 CFM Air Compressors (Model RPQ80 0). Drilling 3½" Ø holes approximately 16'-0" from design tip elevations. We continued drilling a 2½" Ø hole the remaining 16'-0" feet. The hole is cleaned, washed and air jetted and checked for obstruction with a 1" Ø PVC conduit to full depth. A 2" Ø PVC conduit is lowered into the hole to the depth of the 3½" Ø hole for the purpose of sleeving the hole to prevent falling soil and rock debris and to enhance the dropping of the Celtite Resin Cartridges (No. 451: M90 1 3/4" Ø x 12" long). Once the 2" PVC casing is in place again the hole is checked with the 1" Ø PVC conduit to full depth. Upon removing the 1" check rod, one Resin cartridge is dropped in. The hole is checked with the 1" Ø rod again to make sure the cartridge has dropped the full depth. This checking procedure is followed aft the first, second, sixth, twelfth and sixteenth cartridge.

At this time the 2" Ø Conduit casing is removed and the 60'-0" Dywidag Bar is swung and lowered into place with a crane. As the bar starts to penetrate the Resin Cartridges, the drill which has retained its original position connects with the bar through an adapter and the drill starts to spin the bar until the bar reaches maximum depth. The bar continues to be spun for an additional 35 seconds. A rag is stuffed around the bar and the drill is released. The bar is not disturbed until the following day. Prior to testing, a pavement breaker is used to level the rock around the bar for the

8" x 8" x 1" bearing plate. Before testing the bearing and wedge washers, anchor nut and 110 tone Double Action Hydraulic Ram is placed over the exposed bar at rock surface. Ram Jack is supplied by Dywidag with a Direct Reading Guage. Bolt is stressed to 155,000 pounds and locked in tension.

Also, we are enclosing data on Bolt Layout and Bolt elevations Celtite and Sywidag Literature and information on a field soil test bore.

We trust the procedures are acceptable and in accordance with the specification.

Yours truly,

Lou Hutcherson

Lou Hutcherson
Project Manager

LH/sh
cc:file
Enc: 3

Ew 10/12

ORPED-G

Stonewall Jackson Lake Dam, Diversion Channel Rock Anchors

THRU: Chief, Engrg Div

ORPED-G

23 September 1983
Mr. Brown/fl/6946

TO: Engineering Files

1. On 14 September 1983 a meeting was held in the Pittsburgh District Office to discuss the testing and installation of rock anchors in the Stage 1 diversion channel area of the subject project. The purpose of the meeting was to review the details and procedures of the Contractor's revised rock anchor system. Revisions were necessitated by the failure of the limited number of resin grouted and mechanical anchors which had been tested at that time on the project. Present at the meeting were W. Woodburn, Resident Engineer on the Stonewall project; E. Charma (ORDCD-L); and G. Coletti, M. Fausold, S. Long, J. Brown of the Pittsburgh District.

2. Mr. Woodburn opened the meeting by describing the current status of the rockbolting operation on the project. The Contractor has begun to place resin grouted anchors at the reduced spacing and loading proposed in his submittal of 2 September 1983. The Contractor has installed 16 anchors which were loaded to at least 75 kips. Two of these anchors failed to hold the load. Due to reported poor rock and caving in the stressing zone, the Contractor had drilled a total of 30 holes but could only properly install anchors in 16. Bond lengths varied between 9 and 14 feet. Various combinations of hole diameters between two and three inches were tried. A summary prepared by Mr. Woodburn is attached. There had been some difficulty in getting the cartridges down the hole. The Contractor has devised a system of PVC and copper tubing for loading the cartridges which he will test. In addition he has ordered quick-setting celtite grout which is to be used as a seat for the anchor plate.

3. Mr. Coletti then noted the lack of proper procedure followed in changing the anchor type from mechanical to resin-grouted and changing the spacing and loading without completing the specified test section. The Contractor's proposal of 3 August 1983 to use resin grouted anchors instead of mechanical anchors was submitted prior to any testing. In addition, as noted in the District's reply, the proposal was conceptual in nature and lacked sufficient detail. The Contractor should have completed a full test section using the mechanical anchors before proposing an alternate system.

4. Discussion then ensued on the inadequacy of the testing procedure which had been followed for both the mechanical and resin-grouted anchors. It is the opinion of the Pittsburgh District that neither system was adequately tested. Several points were raised:

a. The specifications call for at least ten anchors to be installed and tested in the presence of the manufacturer's representative, whereas in fact only two mechanical anchor installations were tested;

b. Greater bond lengths should have been tried with the resin-grouted anchors in an attempt to attain the specified 155 kip loading;

c. As noted in further correspondence from the Williams Company, greater torquing of the anchor head should have been used and such alternatives as double cone installation tried;

d. In the case of tests for both types of anchors, it appears that the drill holes were not adequately cleaned.

5. Mr. Woodburn agreed that some of these alternatives might enable the anchors to hold a greater load. He pointed out, however, that bringing in the equipment and supplies for additional tests would delay the project and the Contractor might not be able to get the diversion channel and Stage I cofferdam completed by winter as scheduled. In this case, the Contractor might file a claim which would cost more than the additional cost of the anchor scheme now being implemented.

6. It was agreed that the Williams' mechanical anchors would no longer be considered since work had already begun using the grouted anchors. Since some of the anchors that are already installed have bond lengths of 13 to 14 feet, it was requested that Mr. Woodburn have these anchors stressed to loads greater than 75 kips. These anchors would serve as a test section. He was cautioned that the loading should be incremental and should be increased carefully in small increments. At the first indication of incipient failure the loading should be reduced. Results of these tests may indicate that the anchors can maintain a load greater than 75 kips with a longer bond length. Mr. Woodburn stated he would run these tests but doubted the loading could be increased by much since additional loading would increase the percentage of anchors which failed to maintain the design load. He felt that the additional time and drilling to replace the additional failed anchors at a higher design load would offset the advantages of the greater spacing between bolts.

7. As noted above, the Contractor's original proposal lacked sufficient detail. It was requested that Mr. Woodburn have the Contractor, with guidance from the Celtite representative, submit a detailed description of the procedures and equipment he will be using. This should include the drill hole size that is determined to be most effective, procedures for loading cartridges in the holes, number and size of cartridges, mixing rate, setting time, etc.

8. On 23 September 1983 a field inspection was made by Messrs. Long and John, ORPED-C, to observe the installation of the rock anchors according to the above spacing and loading instructions. The installation was proceeding smoothly with only 20 rock anchors remaining to be installed. Stressing of the anchors was not being done at the time, but we were informed that approximately 85% of the Zone 1 and 2 anchors were able to be loaded to 155 kips. Zone 3 was complete with all anchors drilled at the close spacing and loaded to 75 kips. Zones 2 and 1 were being completed according to the spacing and loading required by the specifications. Details of the inspection will be forthcoming in a Memo to Files.

CF:
ORHCD

DISPOSITION FORM

(AR 340-15)

REFERENCE OR OFFICE SYMBOL	SUBJECT
ORPED-G	Stonewall Jackson Dam, DACW59-83-C-0053, Preparation of Monolith Foundations

1 THRU: ORPED ORHCD-L	FROM ORPED-G	DATE 9 Mar 84 Mr. Fausold/rts/4123 CMT 1

TO: Ch, Huntington Constr Div

1. Reference: telephone conversation, Woodburn (ORHCD-SWJ) and Fausold (ORPED-G), 2 March 1984.

2. Mr. Woodburn requested consideration be given to modifying the requirements of specifications Section 2N, paragraph 4.3, which require that a layer of rock be left in place above final monolith grade until the Contractor is prepared to make final cleanup immediately before placing concrete. He stated that the removal of this rock from the deep pits which some of the monolith foundation elevations require would be a considerable problem. He proposed that a final cleanup be accomplished immediately following rough excavation, after which the base of the excavation would be covered by a polyvinyl membrane, which in turn would be covered by 6-10 inches of sand. This covering would be removed when concrete placement was about to commence.

3. The Pittsburgh District has no objection to this proposed change, provided monolith excavation to final grade is completed in sequence from the lower elevations to the higher. The foundation rock observed to date from the confirmatory core borings (about one half of those required) indicates that the foundation will not be subject to rapid weathering, and the proposed protection should be adequate. The Contractor should be required to submit his proposal in writing, stating the type and thickness of the membrane, the thickness of the sand blanket, and the proposed method of sand removal. He should also state his understanding that he is not thereby relieved from the provisions of specification Section 3D, paragraph 11.6, regarding air-water jet cleaning immediately prior to concrete placement and 24-hour saturation of the rock surface. The Contractor should also specifically waive the right to claim for any additional cleanup required by such weathering action which may occur.

4. The basic approval and the associated comments of paragraph 3 have been discussed with Mr. Canning, ORDED-G, and have his concurrence.

Fausold
FAUSOLD

J.F. ALLEN COMPANY AND
WILEY N. JACKSON COMPANY, JOINT VENTURE
P.O. DRAWER 747
WESTON, WV 26452
(304) 269-5550

04 January 1984

Army Corps of Engineers
P. O. Box 608
Weston, WV 26452

ATTENTION: William F. Woodburn
Resident Engineer

RE: Stonewall Jackson Lake Dam
DACW59-83-C-0053
PROPOSED MONOLITH DRILLING
AND BLASTING SCHEDULE

Gentlemen:

Pursuant to the contract specification and drawings we respectfully submit for your review the following drilling and blasting plan for Monoliths 1 - 9. Phase I - Monoliths 1 - 9.

SPECIFICATION SECTION 2D - PARAGRAPH 5.1 - 8

PARAGRAPH 5.1 - Explosives will be stored, handled and used in accordance with the best practice with approval from the Resident Engineer and in accordance with Federal, State and Local Laws and regulations. We will comply with all special rules and regulations by the authorities having jurisdiction, or by the Resident Engineer regarding construction of and storage in magazines, precautions on blasting work and the like. We assume responsibility of all operations within our control. Our blasting foremen has over five (5) years experience in control blasting and he is responsible for the blasting plan, supervising of drilling, loading and safety.

PARAGRAPH 5.1.1 - Explosives will be stored in suitable magazines in an approved location. Detonators will be kept in a separate magazine. The magazine will be plainly marked with large letters - EXPLOSIVES - DANGEROUS - and will be locked at all times. Keys to unlock the magazine will be kept only by our drilling and blasting foreman, William Young. Each magazine will have around it a cleared area suitable barricaded.

PARAGRAPH 5.1.2 - Our magazine keeper is competent, trustworthy, sober, and familiar with the handling, care and storage of explosives and detonators and he will be responsible for maintaining the cleared area around the magzzines. Mr. Young's primary duties are to assure the entire blasting operations are conducted in an absolute safe manner and the explosives and detonators are kept in magazines and the magazines secured.

PARAGRAPH 5.1.3 - Accurate daily records will be kept by Mr. Young and he

will keep records for each piece of explosive, detonator, and equipment from the time of delivery to the magazine until its discharge in use. No explosives will be stored or used until it has been plainly labeled for identification and accepted as new stock in sound condition. Containers for explosives will be approved by the Resident Engineer in advance of operations. Drilling and blasting will be done at such times and under such restrictions and conditions as the Resident Engineer will approve.

PARAGRAPH 5.1.4 - We respectfully submit this drilling and blasting plan and it is to include all rock excavation for monoliths one through nine. Enclosed will be drawings indicating the pertinent data on the location, depth, and area of the blast; diameter, spacing, depth, over depth, pattern and inclination of blast holes; the type, strength, amount, distribution and powder factor for the explosives used per hole and per blast, the sequence and pattern of delays; and description and purpose of special methods, to control dust the air driven track drills are equipped with vacuum type dust collectors. No drilling will take place until the blasting plan has been approved. All blast holes will be checked for spacing and depth prior to loading. All loading and blasting will be done in the presence of the Resident Engineer or his representative. Blast holes other than holes used for presplitting and linedrilling will not be drilled to depths greater than three feet above final grade. Drilling of blast holes to full depth plus eight inches may be incorporated in our blasting operations where the depth is three feet or less and its understood the bottom foot of the hole is padded with sand. Also, its understood acceptance by the Resident Engineer of blasting data will not relieve us as the contractor of our responsibility to produce satisfactory results as set forth in the specifications. We understand no deviations from the approved plan will be permitted without prior written approval of the Resident Engineer. Drilling and blasting will be done only to the depth, amount and at such locations, with explosives of such quantity, distribution and density that will not produce unsafe or damaged rock surfaces or damaged rock beyond the prescribed excavation limits. It's understood the rock to be excavated has vertical and lateral variations in hardness and texture and contains open and filled seams and joints. As excavation operations progress, the drilling and blasting procedures will be determined by satisfactory results achieved. When drilling and blasting program results in damages to the excavation, we the contractor will devise and implement methods which will prevent further damage. No blasting will be done within 200 feet of concrete or grout which has been in place less than seven days, nor within 50 feet of any concrete or grout that is older than seven days, except for monolith No. 10 excavation or as authorized in writing by the Resident Engineer. Blasting will be conducted in accordance with applicable provisions of the Department of the Army, Corps of Engineers' Handbook "SAFETY AND HEALTH REQUIREMENTS MANUAL" Em 385-1-1, April 1981.

PARAGRAPH 5.2 - Blast Vibration monitoring

PARAGRAPH 5.2.1 - Vibration monitoring of all blasts will be recorded. The blasts will be monitored to insure that peak particle velocity, measured at the nearest permanent concrete structure to the blast, will not exceed 5 inches per second, except in monolith No. 10 excavation, where the peak particle velocity will not exceed 2 inches per second.

PARAGRAPH 5.2.2 - In addition to contract specification we respectfully submit additional blast vibration literature information which will be enclosed.

PARAGRAPH 5.2.3 - Seismic Specialist. We the contractor do have a specialist qualified in vibration control methods and capable of analyzing results obtained from seismograph readings. A minimum of 30 days prior to commencement of drilling and blasting operations, we the contractor will provide the Resident Engineer with the resume of the seismograph specialist to include, but not be limited to past experience, training and education. Also, we understand the acceptablility of the specialist is subject to the approval of the Resident Engineer.

PARAGARPH 5.2.4 - Measuring and recording instruments. We the contractor shall provide suitable instuments to measure and record ground movements caused by blasting. The instruments will record three orthogonal componets (vertical, radical and tranverse with respect to the blast) of particle velocity directly. Seismograph equipment literature is enclosed.

PARAGRAPH 5.2.5 - Our seismograph operator is a qualified person capable of setting up the instruments at designated locations and effectively recording the blast.

PARAGRAPH 6.3 - Presplit Blasting

PARAGRAPH 6.3.3 - Structures. In developing a presplit face, drilled holes will be 3 inch diameter spaced 18 inches on centers. Such faces will be undisturbed rock and will be within 6 inches of the neat lines shown on the drawings, except that no rock will project inside the neat lines as shown for the structures. Depths of drilled holes as measured along faces will be to full depth of excavation. Unless full depth is drilled and offset a minimum of one foot bench will be required every 20 feet in depth of vertical face to permit the roto air track drill access after lift of blasted rock is removed. All production drilling and blasting will not exceed 20 feet in depth. The final three feet will be drilled, shot and removed in an on going separate operation. All loose and unsound rock fragments will be removed and the rock faces will be washed down with air and water jets before the concrete is placed. Presplit or line drilled or otherwise produced rock surfaces against which concrete is to be placed will be protected from damage by appropriate means in accordance with section 2N Rock Reinforcement and Protection, until concrete is placed.

PARAGRAPH 6.4 - Line Drilling will be performed as herein indicated by enclosed information and as approved by the Resident Engineer. Drilled holes will be 3 inch diameter spaced 6 inches on centers to the full depth of the excavation as indicated on the drawing of its respective location. The line drill hole will be drilled with equipment competent to maintain the alignment and plane of the drilled hole pattern throughout the full depth of the hole. Line drilling will be performed in such a manner that the faces remaining shall be undisturbed rock, and that the faces will not project inside the excavation lines as shown on the drawings. Line drilling will be done at the downstream limits of the shear key in the stilling basin floor, at the vertical steps between monoliths as shown on drawing No. 037-U1-40/2 and the downstream excavation lines of monoliths 6, 7 and 8.

PARAGRAPH 6.5 - Dressing and trimming. Loose, fractured or projecting rock will be removed from the slopes by barring or air tooling, and the slopes will be dressed to eliminate irregularities. We as the Contractor will maintain the slopes and we will scale loose rock from the slopes and faces of the excavation throughout the life of the contract.

PARAGRAPH 7 - Shoring and Sheeting. Safety is foremost on this project and all attempts will be made to protect our employees from unfinished work and workmen from the danger of caving and slides. If shoring and sheeting are necessary, it will be installed in a workmanlike manner, in accordance with the requirements of the Corps of Engineers manual, Em 385-11, Dated 1 April, 1981, entitled "SAFETY AND HEALTH REQUIREMENTS MANUAL" and will be placed in such a way as to afford ready inspection of an ample clearance for permanent work. Sheeting will be so constructed and carried to such depths as to prevent excess inflow of water and intrusion of sand and other materials. Shoring and sheeting will not be left in place unless approval is given by the Resident Engineer. Details of proposed shoring and sheeting will be submitted to the Resident Engineer for approval in accordance with Paragraph "shop drawings of Part I - Special Provisions.

If there are any further questions, please do not hesitate to contact this office.

Respectfully yours,

Lou Hutcherson
Project Manager

LH/sh
cc: file
Enc:

ORHCD-SWJ January 31, 1984

SUBJECT: Blasting Schedule, Stonewall Jackson Lake Project
Contract No. DACW59-83-C-0053

J.F. Allen Co. & Wiley N. Jackson,
A Joint Venture
P.O. Drawer 747
Weston, West Virginia 26452

Gentlemen:

Your proposed Monolith Drilling and Blasting Schedule, submitted on 11 January 1984, for my review appears satisfactory, except for the following items:

1. Foundation elevations are tentative and actual elevation will be determined in the field.

2. In the last three (3) feet, the production shot pattern must be less than the burden thickness.

3. Tentative line drilling locations are indicated in red on your sketch.

4. This schedule does not fulfill the contract requirements of Para. 20-5.1.4, which requires that twenty four (24) hours prior to drilling for each blast, you shall submit for approval on an approved form, the pertinent data on the location, depth and area of the blast; diameter, spacing, depth, over-depth, pattern and inclination of blast holes; the type, strength, amount, distribution and powder factor for the explosives used per hole and per blast; the sequence and pattern of delays; and the description and purpose of special methods.

Sincerely,

WILLIAM F. WOODBURN
Resident Engineer
Authorized Representative
of the Contracting Officer

CF:
ORHCD
ORHSU
ORHCD-L

WILEY N. JACKSON COMPANY, JOINT VENTURE
P.O. DRAWER 747
WESTON, WV 26452
(304) 269-5550

22 February 1984

Army Corps of Engineers
P. O. Box 608
Weston, WV 26452

ATTENTION: Mr. William F. Woodburn
Resident Engineer

RE: Stonewall Jackson Lake Dam
DACW59-83-C-0053

Gentlemen:

In reference to Contract Specification, Section 2N, Paragraph 3.7.3, Monolith Faces and Paragraph 3.8, Installation of Chain Link Fabric, we respectfully submit an alternate Rock Bolt Installation method.

In lieu of an expansion type rock bolt as indicated on sheet 037-U1-19/3 of the contract drawings we propose the Dywidag Threadbar Bolt System with the Celtite Resin Cartridges in both areas as referenced above.

The diameter of the rock bolts will be at least the minimum size as stated in the specifications. In addition, the vertical excavation face rock bolts will have 2'-0" longer rock embedment with a minimum of five (5) Celtite Resin Cartridges. Also, we propose using a minimum of two (2) Celtite Cartridges for bolt anchoring the Chain Link Fabric.

All other specifications will remain unchanged; spacing, testing and procedures.

This proposed change will be at no additional cost to the Government.

See enclosed drawing on embedded rock bolts. Also, we are enclosing information on Dywidag Bolts and on Celtite Cartridges.

If additional information is required, please contact our office.

Respectfully yours,

Lou Hutcherson
Project Manager

LH/sh
cc: file
enc: as noted

DISPOSITION FORM

For use of this form, see AR 340-15, the proponent agency is TAGCEN.

REFERENCE OR OFFICE SYMBOL	SUBJECT
ORHCD-SWJ	Stonewall Jackson Lake Project - DACW59-83-C-0053 Rock Bolt Installation at Monolith Faces and Chain Link Fabric Installation

~~TO~~ THRU ORHCD-L 2/27
Thru ORPED
TO ORPED-D

FROM ORHCD-SWJ

DATE 22 February 1984 CMT
WOODBURN/msl

1. Enclosed for your review is a proposal from the dam contractor requesting to use Dywidag Threadbar Bolt System with Celtite Resin cartridges in lieu of expansion type rock bolts.

2. We successfully used Dywidag anchors for the stabilization of the diversion channel.

3. I feel they will work successfully for this application.

W. F. Woodburn
WILLIAM F. WOODBURN
Resident Engineer

Enclosure

CF:
ORHCD-L
ORHCD

ORPED-DM (22 Feb 84)

THRU: (1) ORPED
(2) ORHCD-L 3/15

FROM: ORPED-D

DATE: 13 Mar 84 CMT 2
Mr. Ardine/js/6881

TO: (3) ORHCD-SWJ

1. The substitution as requested in paragraph 1 of CMT 1 is acceptable. Table A marked in orange on sheet titled "Rock Bolts - Size, Depth of Holes and No. of Celtite Cartridges" is added in an attempt to summarize pertinent information contained within the voluminous inclosures. The Contractor should evaluate whether the information in Table A does indeed reflect his intentions and confirm and/or resubmit as required.

2. The statement that the proposed change will be at no additional cost to the Government made in the Contractor's cover letter, dated 22 February 1984, appears to be ambiguous. The bid schedule indicates Item No. 126, Rock Bolts: Monolith - Excavation Faces, is to be paid at a unit price per lineal foot. Since the Contractor has not addressed the equivalence of the bond lengths required for each system, has the Contractor accepted by inference that any additional bond length requirements of the substitute system would be subtracted from the total installed length; so in actuality there would be no additional cost to the Government.

Coletti
COLETTI

wd all incl
Added 1 incl
1. Table A

(R-18)

ORHCD-SWJ March 19, 1984

SUBJECT: Rock Bolt Installation at Monolith Faces and Chain Link Fabric Installation, Construction of Stonewall Jackson Lake Contract No. DACW59-83-C-0053

J.F. Allen Co. & Wiley N. Jackson,
A Joint Venture
P.O. Drawer 747
Weston, West Virginia 26452

Gentleman:

Your request to substitute Dywidag System with celtite resin cartridges is acceptable providing the hole diameter conforms with table "A" on attached sketch and provided that there is no additional cost to the Government.

Sincerely,

WILLIAM F. WOODBURN
Resident Engineer
Authorized Representative
of the Contracting Officer

Enclosure

CF:
ORHCD
ORHSU
ORHCD-L

ROCK BOLTS - SIZE, DEPTH OF HOLES AND No. OF CELTITE CARTRIDGES

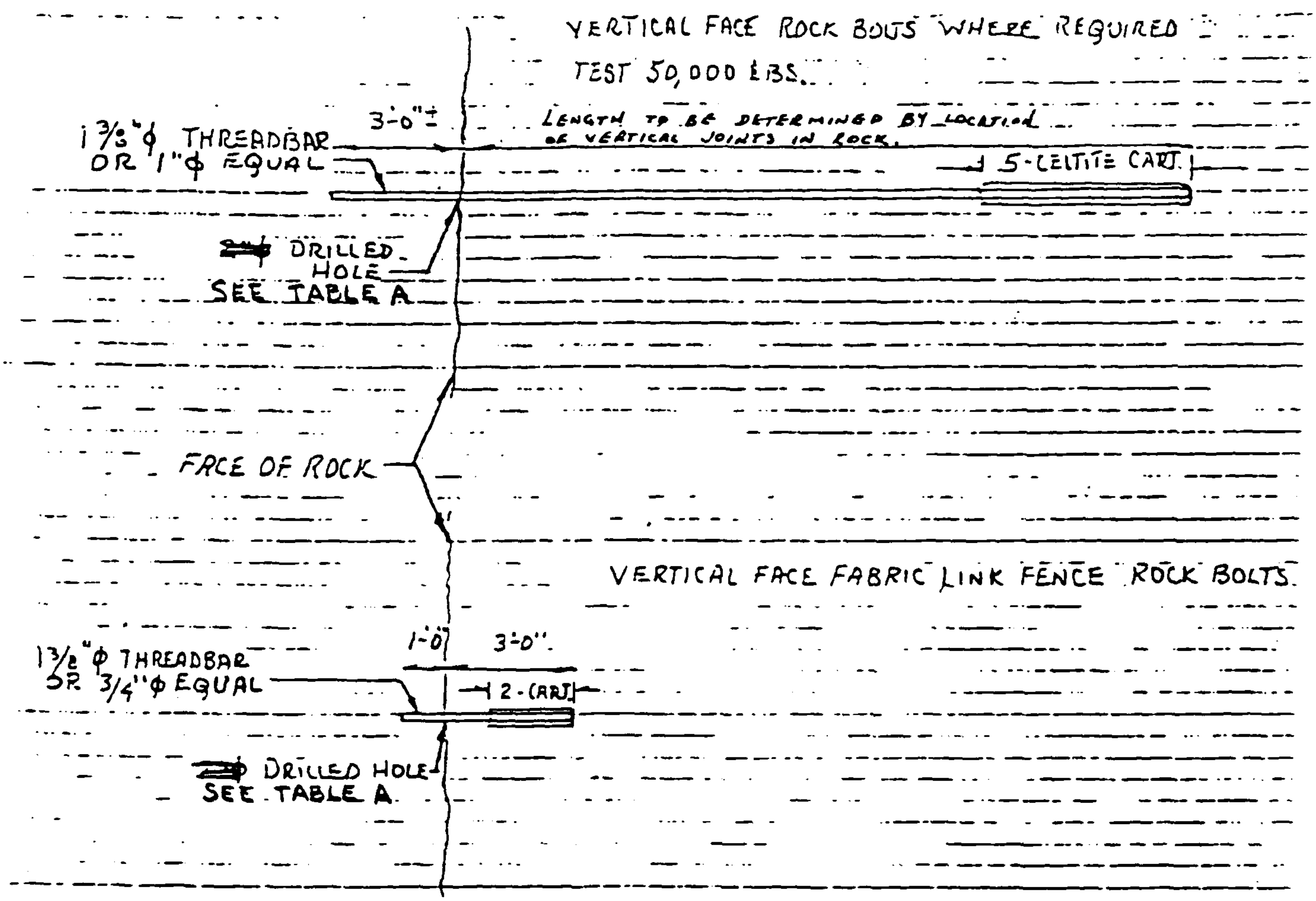


TABLE A

ROCK BOLT DIA	HOLE SIZE (1) DIA	CARTRIDGE SIZE (2) DIA
1 3/8"	2"	1 5/8"
1"	1 5/8"	1 3/8"
3/4"	1 1/8"	1"

(1) DSI page 6

(2) CELTITE CARTRIDGE Data

J.F. ALLEN COMPANY AND
WILEY N. JACKSON COMPANY, JOINT VENTURE
P.O. DRAWER 747
WESTON, WV 26452

29 February 1984

Army Corps of Engineers
P. O. Box 608
Weston, WV 26452

ATTENTION: Mr. William F. Woodburn
Resident Engineer

RE: Stonewall Jackson Lake Dam
DACW59-83-C-0053
West Fork River
MONOLITH FOUNDATION ELEVATION

Gentlemen:

In reference to section 2D, paragraph 5.1.4 of the contract specification, it states that blast holes other than holes used for presplitting as hereinafter specified, shall not be drilled to depths greater than three feet above the final grade. We understand this to mean the last three feet to be drilled, shot and removed as a unit just prior to placing concrete on the founding elevation. If this is the correct interpretation, we respectfully propose an alternate plan.

The last three feet above final grade would still be removed as specified. However, this operation would immediately follow the major excavation operation of each monolith. We would in turn protect the final grade with a cover of 4 mil polyethlene sheet plastic and 6" of clean sand.

Also, this scheme would give you considerably more time to evacuate the final grade and it would give both of us more flexibility with the requirements of the blasting criteria, i.e. we cannot blast within 200 feet of freshly placed structual concrete for seven days and thereafter not within 50 feet of structual concrete. In construction Stage I excavation operations all monolith final grades will be exposed, inspected and protected before concrete is placed on any monolith.

The sand protection will be maintained moist and heavy and track equipment will not be permitted within the protected area.

Also, this proposal will be at no additional expense to the Government.

Respectfully yours,

Lou Hutcherson
Project Manager

LH/sh
cc: file

ORHCD-SWJ May 8, 1985

SUBJECT: Additional 6 Inch Core Drilling In M-12, Stonewall Jackson Lake
Contract No. DACW59-83-C-0053

J.F. Allen Company and
Wiley N. Jackson, AJV
P.O. Drawer 747
Weston, West Virginia 26452

Gentlemen:

This letter will confirm my verbal instructions given to you on 07 May 85 to proceed immediately with the drilling of five, 6 inch cores in the upstream end of Monolith No. 12.

This request was made to me by Marshall Fausold via Stu Long on 07 May 85.

Sincerely,

WILLIAM F. WOODBURN
Resident Engineer
Authorized Representative
of the Contracting Officer

CF:
ORHCD
ORHCD-L
ORHSU

J.F. ALLEN COMPANY AND
WILEY N. JACKSON COMPANY, JOINT VENTURE
P.O. DRAWER 747
WESTON, WV 26452
(304) 269-5550

04 September 1985

Army Corps of Engineers
P. O. Box 608
Weston, WV 26452

Attn: Mr. Wm. F. Woodburn
Resident Engineer

RE: Stonewall Jackson Lake Dam
DACW59-83-C-0053
REDIVERTING THE RIVER THROUGH
THE FLOOD CONTROL SLUICES

Dear Sir,

We respectfully submit for your review the following proposal for re-diverting the river through the sluiceways. The Stage II Concrete Placement has been placed on Monolith 1 to Monolith 3 to roadway elevation. Monolith 5 to Monolith 9 will also be to roadway elevation. Monolith 10 to Monolith 15 will be completed to a minimum elevation of 1055.00.

All flood control and quality control sluice gates and related appurtenances will be tested and maintained by the permanent hydraulic system and in compliance with Paragraph 8, Section 5A and Paragraph 15, Section 15A. The flood control sluice maintenance bulkhead, bulkhead guides and trash racks will be installed and tested in Monoliths 6, 7 and 8 and in compliance with Paragraph 8, Section 5A and Paragraph 7, Section 5C.

The quality control towers (Monoliths 5 and 9) will be topped out (elevation 1088.00) prior to rediversion. We have not received from our fabricator the trash racks, maintenance bulkheads, intake and hoist gates for the water quality gates. However, these items are scheduled on site within the next three months and will be installed this year in compliance with Paragraph 8, Section 5D. This activity will be done in the dry after the diversion as the tower openings start at elevation 1038.00 and flood forecast above this has a 9 year frequency at this time of year. Should we have a flood condition prior to the completed installation of this system we assume the cost of cleanup and related costs.

This month the draft tube sluice guide and gate will be installed, tested and in compliance with Paragraph 8, Section 5D of the contract specifications.

Prior to rediverting the river all debris in and around the cofferdams and stilling basin will be removed. The diversion channel Stage II will be

plugged at Sta. 2+0 to Sta. 3+0 and Sta. 5+0 to Sta. 5+75 (as shown on the alternate Stage II Diversion Channel Phase II Dwg. 2 of 5). At this point rediverting the river through the sluices will proceed.

T e week of September 16, 1985 we are scheduling the removing of the cofferdams and anticipating it taking approximately two weeks. Rediverting the river will probably take place the first week of Ootober.

Monolith 4 would then be completed as rapidly as possible, providing that the good weather holds. I remain,

Respectfully yours,

Lou Hutcherson
Project Manager

LH/sh
cc: file

J.F. ALLEN COMPANY AND
WILEY N. JACKSON COMPANY, JOINT VENTURE
P.O. DRAWER 747
WESTON, WV 26452
(304) 269-5550

21 February 1986

Army Corps of Engineers
P. O. Box 608
Weston, WV 26452

Attn: Mr. Wm. F. Woodburn
Resident Engineer

RE: Stonewall Jackson Lake Dam
DACW59-83C-0053

Dear Sir,

We hereby submit our proposal for the relocation of surface drilling for the grout holes.

Drilling would be accomplished in accordance with the specification Section 20 - B, Paragraph 7.3 and with suggestion and comments discussed with Mr. Dave Nugen, Corps Engineer Representative.

Enclosed are the drawings of surface drilling for grout holes on the right and left abutments.

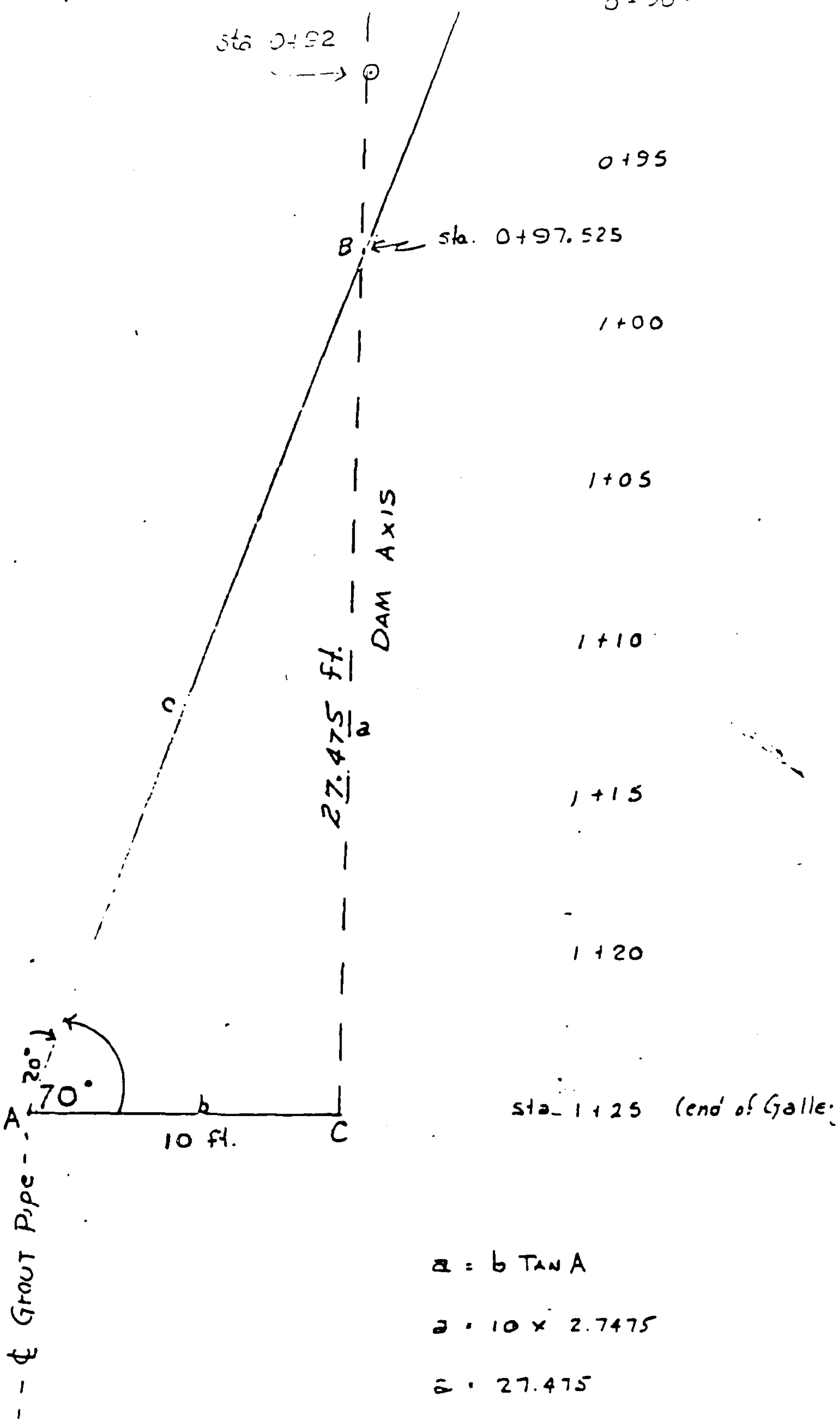
Please advise us at your earliest convenience if this scheme meets with your approval. I remain,

Respectfully yours,

Emilio Mendenilla
Resident Engineer

EM/sh
cc: file
enc: as noted

INSTALLATION	COMPUTATION	NUMBER
COMPUTED BY		
CHECKED BY		



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$a = 10 \times 2.7475$

$a = 27.475$

INSTALLATION | PLAN VIEW of Abutment 2 EL 1055.55
COMPUTED BY | COMPUTATION w/Rd @ 1102 Superimposed | NUMBER
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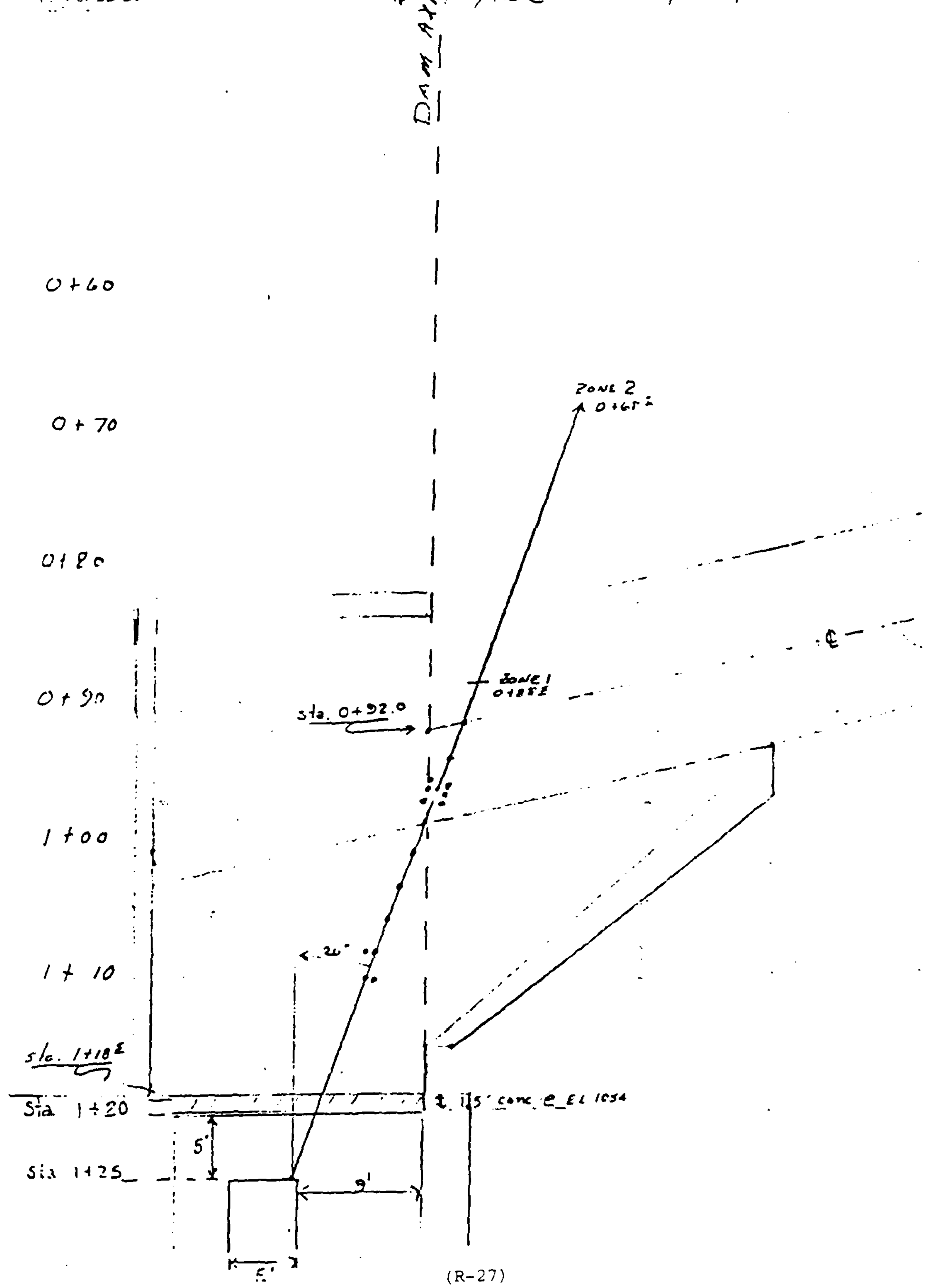
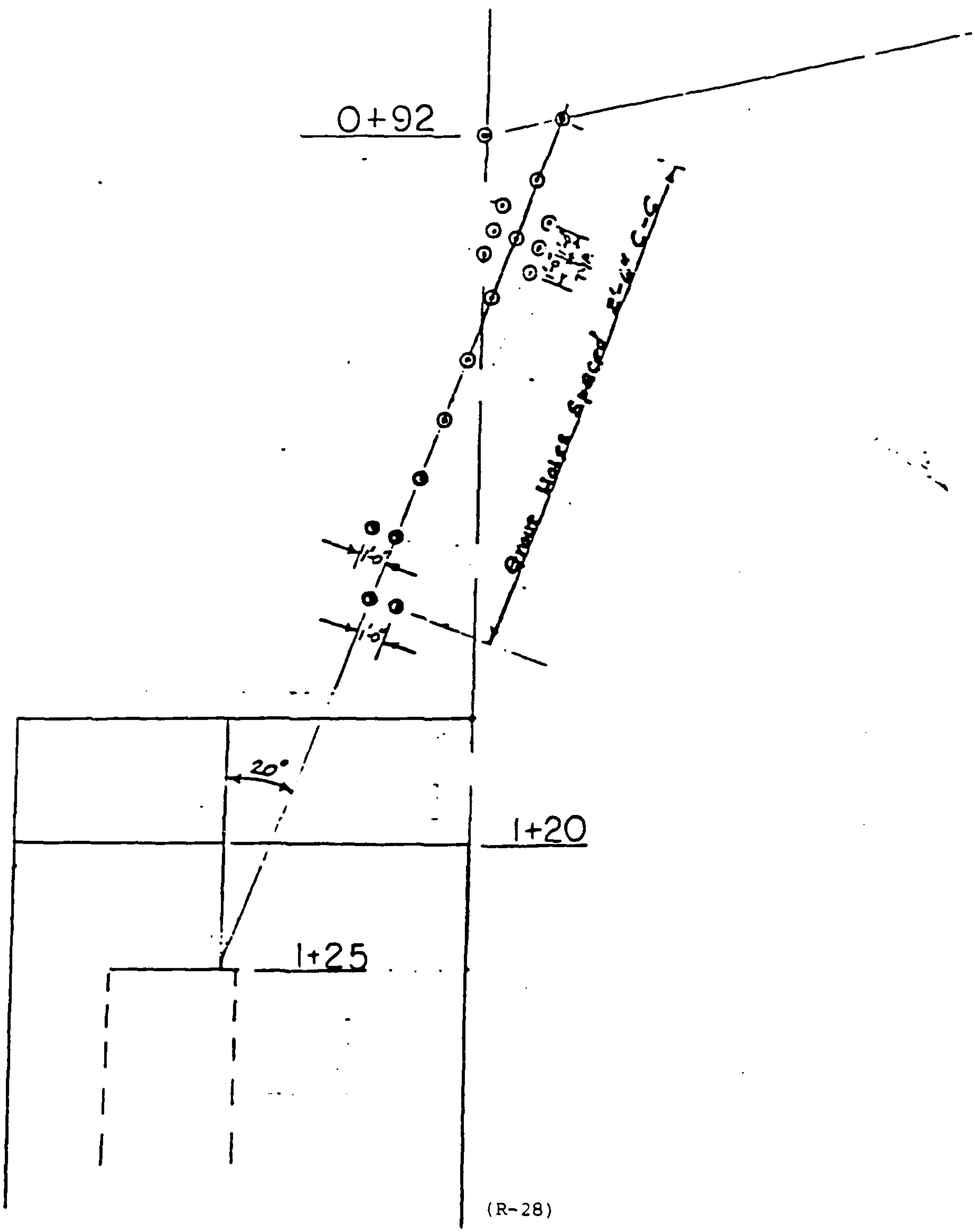


(R-27)



(R-28)

J.F. ALLEN COMPANY AND
WILEY N. JACKSON COMPANY, JOINT VENTURE
P.O. DRAWER 747
WESTON, WV 26452
(304) 269-5550

14 May 1986

Army Corps of Engineers
P. O. Box 608
Weston, WV 26452

RE: Stonewall Jackson Lake Dam
DACW59-83-C-0053

Dear Sir,

We hereby resubmit our proposal for the relocation of surface drilling for the grout holes.

Drilling would be accomplished in accordance with the specification section 20, Paragraph 4.3 and with suggestion and comments discussed with Mr. Dave Nugen, Corps Geologist.

Enclosed details and drawing of surface drilling adjacent to Monolith 16 and left abutment.

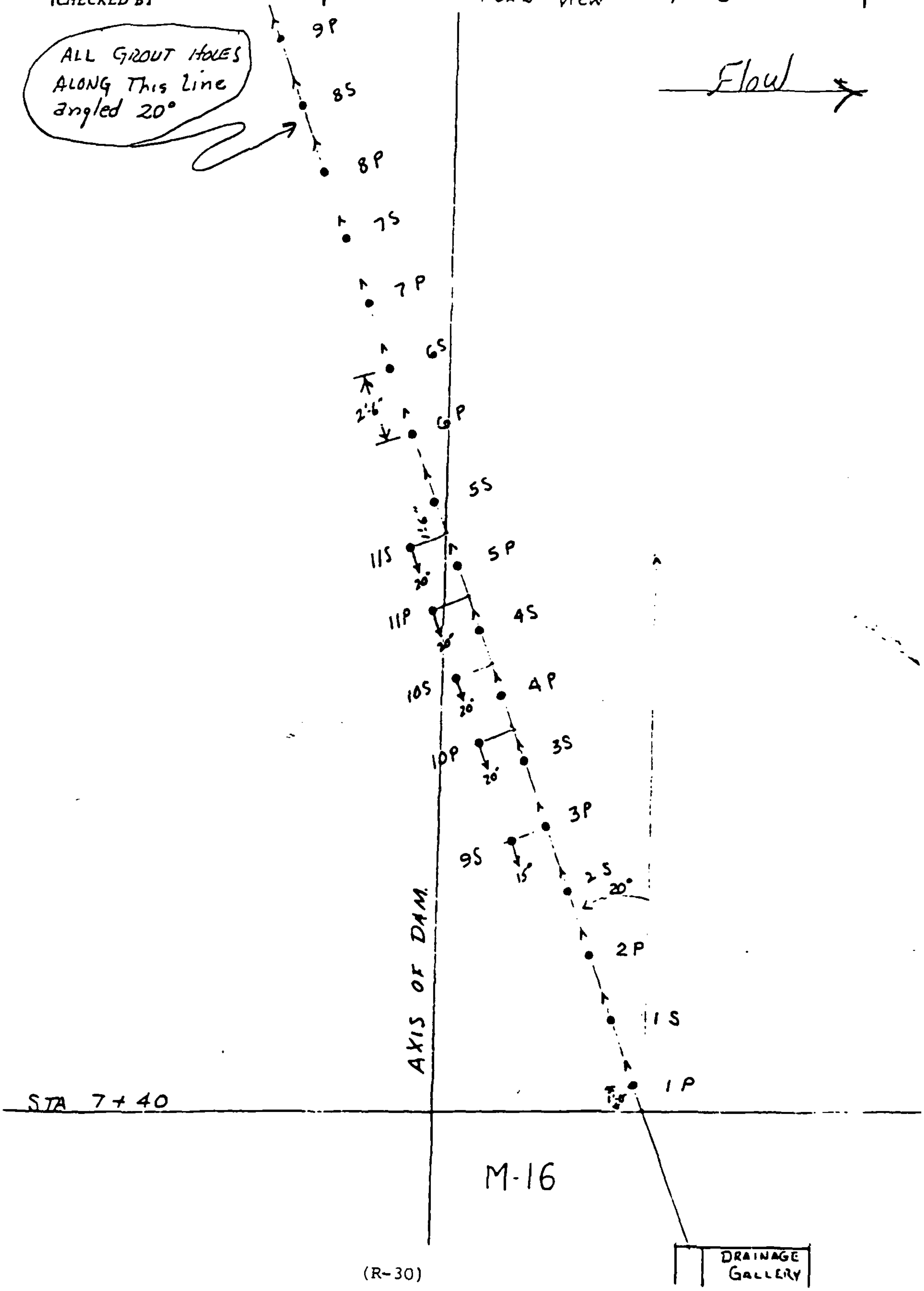
Please advise us at your earliest convenience if this scheme meets with your approval. I remain,

Respectfully yours,

E. Mendenilla
Field Engineer

EM/sbh
cc: file
enc: as noted

INSTALLATION	SUBJECT Surface Grouting Detail - Left Abutme	
COMPUTED BY	COMPUTATION Plan View - 1" = 5'	NUMBER
CHECKED BY		



(R-30)

SMITH/dkm/5280

December 30, 1986

Construction Division
Contract Administration Branch

SUBJECT: Contract No. DACW59-83-C-0053, Construction of Dam, Stonewall Jackson Lake Dam, West Fork River, West Virginia

The J. F. Allen Company and
Wiley N. Jackson Company
Post Office Box 49
Clarksburg, West Virginia 26301

Gentlemen:

As a result of an inspection made in accordance with Contract Clauses of the referenced contract, all work under the referenced contract was found to be complete except for final testing and correcting punch list items, and is accepted for beneficial occupancy as of December 19, 1986.

Sincerely,

Robert D. Brown III
Colonel, Corps of Engineers
Contracting Officer

Copies Furnished:

ORHCD-A, wd
ORHCD, wd
ORHCD-SWJ, wd
ORHCD-L, wd
ORHOC
ORHRM-F
ORPOP
ORHED (dupe)
ORHED-B
ORHSU

SHELDON CD-A
DEEDS CD
EVERSOLE OC
MATTHEWS EA
JOBE DD
BROWN DE

ORDED-G

83-C-0057

9 November 1983

Copy

MEMORANDUM FOR FILES

SUBJECT. Stonewall Jackson Dam, Adjustment to Permanent Cofferdam Cross Section

On 3 November 1983, as a result of observations during an inspection conducted that date in company with Messrs. Fonceiier and Canning (ORDED-G), the possibility was discussed of adjusting the cross section of the upstream cofferdam to eliminate the portion of the dike shown on Drawing 037D-UT-19/2 as being a closure dike and the associated three-foot thick transition zone. This zone would be constructed, instead, of impervious fill. Upon return to the District Office on 4 November, the stability calculations made during the design of the cofferdam were reviewed. It appeared from this review that the factor of safety of the upstream slope of the permanent cofferdam using an entirely impervious material had previously been calculated and was 1.20, which is less than the required 1.25. However, this analysis had been made assuming a rapid-drawdown condition involving complete saturation of the impervious fill. This is an unlikely circumstance for a structure of this type where high river stages leading to saturation should be of short duration. Furthermore, the construction procedure utilized by the Contractor has been to construct a large and substantial diversion dike immediately upstream of the location of the permanent cofferdam. In discussion with Mr. Woodburn, Resident Engineer, he stated that it was his intent to push material from the diversion dike into the space between the diversion dike and the cofferdam to create a level berm against the upstream face of the permanent cofferdam. This will result in a very substantial increase in the stability of the upstream face of the permanent cofferdam. In view of these two circumstances tending to increase the stability of the upstream face of the permanent cofferdam, Mr. Woodburn was advised by telephone this date that the District has no objection to the construction of that zone labeled as transition material and closure dike out of impervious fill. This will create an easier construction situation, and should result in a simplified placement procedure and possibly a small economy of operation.

MARSHALL [illegible]
Chief, Geotechnical Branch

CF:
ORDED-G

Lardieri ED

Kovanic ED

ORPED-G 5 March 1984

MEMORANDUM FOR RECORD

SUBJECT: Stonewall Jackson Trip Report, Contract No. DACW59-C-83-0053

1. On 27 and 28 February 1984, an inspection was held at the Stonewall Jackson Lake Dam site. Those in attendance included Mr. Pete Hart (DAEN-CWE-SG), Mr. Charlie Canning (ORDED-G), Mr. Pat Oshel (ORHCD-I) and Messrs. Stuart Long and Robert John of the Pittsburgh District Geotechnical Branch. The major purposes of the visit were to update Mr. Hart and Mr. Canning on progress at the project and to discuss proposed founding elevations for the right abutment monoliths 1 thru 5.

2. Following arrival at the site on 27 February, the group toured the dam site accompanied by Mr. David Nugen, Project Geologist, and Mr. Gordon Louden, Asst Resident Engineer. The slide that has developed on the left abutment above the rock buttress continues to worsen. Currently it has caused a large portion of the gravel blanket located between the overburden and the rock buttress to buckle. This particular area now has the appearance of being a step leading down to the horizontal surface of the buttress. The overall condition of the left abutment was noted by the inspection party. The slide is of no immediate concern to the safety of the dam excavation or diversion channel and will continue to be monitored.

3. The excavation proceeding on the right abutment was also inspected. The rock exposed in the retaining wall and turnaround area is a massive sandstone with numerous clay filled, nearly vertical joints up to three inches wide. The overburden removal and blasting done in this area exposed these roughly north-south trending joints spaced three feet apart. A large backhoe was brought in to try and pry two large blocks apart at one of these joints but there was no movement. Immediately underlying this sandstone unit is a weathered shale unit which breaks down rapidly on exposure. Further down the abutment overburden and rippable material were being removed.

4. Eleven of the exploratory borings being drilled to confirm proposed founding elevations have been completed. These borings represent Monoliths 1 through 9. All members of the inspection group were pleased with the high quality and excellent recovery of the four-inch core. After inspection of the core and comparison with logs of previously drilled borings, agreement was reached on the following founding elevations for Monoliths 1 through 5:

Monolith 1 - Elevation 1045
Monolith 2 - Elevation 1022
Monolith 3 - Elevation 995.6
Monolith 4 - Elevation 995.6
Monolith 5 - Elevation 987.4

Four of the borings representing Monoliths 6 through 9 (Nos. 202, 210, 211, 212) were completed very recently and the core had not yet been logged by Mr. Long. Preliminary founding elevations for these monoliths were agreed on based on a cursory examination of these borings, but a final decision was deferred pending a more detailed examination of the core by Mr. Long and Mr. Oshel.

5. At the debriefing meeting following the core inspection, there was some discussion of methods for protecting rock surfaces in the foundation excavations. It was agreed that the jointed sandstone blocks in the retaining wall area of the right abutment be secured with horizontal resin grouted rock bolts. These would act as dowels and would be left unstressed to avoid further damage to the rock. The need for quick application of the Celtite protective coating on argillaceous surfaces was emphasized, and the concept of leaving a buffer zone above the coal in monoliths 3 and 4 prior to final blasting to foundation grade was discussed.

Mr. Hart and Mr. Canning expressed their general satisfaction with the progress of the project to date, and encouraged the Huntington and Pittsburgh District representatives to continue their careful inspections as excavation proceeds. The importance of keeping all parties involved in this project informed of developments and consulting with one another was emphasized. To date nothing unexpected has shown up as a result of the core drilling or common excavation.

Stuart B. Long
STUART B. LONG
Chief, Geology Section

ORDED-G 14 March 1984

MEMORANDUM FOR THE RECORD

SUBJECT: Trip Report. Inspection of the on-going work at Stonewall Jackson Dam, and determine monolith foundation grades.

1. On 27 and 28 February 1984, the undersigned inspected the on-going structural excavation and the rock cores being drilled by the contractor.

2. Purpose: The purpose of the trip was to meet with Pittsburgh and Huntington Districts and Office of the Chief personnel and to inspect the on-going excavation and the rock core samples being taken for conformation of design selected foundation grades.

3. Attendees:

(a) Mr. Stu Long, Geologist, ORPED-G
(b) Mr. Robert John, Geologist, ORPED-G
(c) Mr. Pat Osnel, Geologist, ORHCD-I
(d) Mr. Bill Woodburn, Resident Engineer, ORHCD-SWJ
(e) Mr. Gordon Loudin, Asst. Resident Engineer, ORHCD-SWJ
(f) Mr. Dave Nugen, Project Geologist, ORHCD-SWJ
(g) Mr. Pete Hart, Geologist, OCE
(h) Mr. Charles Canning, Geologist, ORDED-G

4. Background: During the review of the plans and specifications, it was agreed that additional core borings should be included in the contract for conformation of the selected design grades. A total of 18 boring locations were selected for the contract: eleven (11) in phase one and seven (7) in phase two. Once the contractor had completed phase one drilling, the above attendees would meet at the site, review the core samples and select the final foundation grades. See Attachment 1.

5. Observations:

(a) On the afternoon of 27 February 1984, the group met with project personnel for a briefing on construction in progress and a site inspection. The site visit began with an inspection of the rock buttress on the left abutment. During a previous site visit by the undersigned in November 1983, a small slide had appeared above the rock buttress. At this time the inclinometers did not indicate any movement. During the time between the November 1983 visit and this visit, the slide had become more active. Several of the inclinometers had been squeezed shut at a depth of 13$\pm$ feet. The filter drain had been pushed up several feet and a small area downstream showed signs of movement. See Attachment 1 and Photographs 1 thru 7.

(b) The group then visited the right abutment and inspected the excavation in progress. The contractor had excavated down to rock near the top of the abutment. Rock in this area is somewhat lower than projected on the drawings. Also the excavation has revealed a series of clay filled stress relief joints along the top of the abutment. See Attachment 1 and Photograph Nos. 8 thru 14. During the inspection, the contractor attempted, unsuccessfully, to scale down a slab of rock containing a clay filled joint with a backhoe. See Photograph No. 14.

(c) After inspecting the right abutment, the group inspected the upstream and downstream cofferdams and the floodway. The contract called for a concrete floodway structure, however, the contractor submitted a VE proposal for the use of three concrete culverts which was approved by Pittsburgh. The savings to the government amounted to approximately $1300.00. See Photograph Nos. 15 thru 18.

(d) On the morning of February 28, 1984, the group inspected the core samples laid out by the site personnel. The following borings had been logged and were inspected in detail by the group Boring Nos. 200, 201, 217, 216, 215, 214, 213 and 212. Boring Nos. 202, 210, and 211 were in the process of being logged, however, the group did inspect the core making comparisons with the above logged borings. See Photograph Nos. 19 thru 24.

6. Discussion:

(a) Left Abutment Slide: The inclinometers indicate that the depth of sliding is around 13± feet. However, the rock buttress appears to be functioning since the gravel filter drain between the abutment material and the rock buttress has been pushed up 2 to 3 feet with no apparent horizontal movement of buttress. See Photograph Nos. 5 and 6. The small slides downstream of the rock buttress will continue to move, however, it does not appear to pose a major problem at this time (see Photograph No. 4).

(b) Right Abutment: The stress relief joints filled with clay could pose a safety problem during the construction life of the dam and may require rock bolts as an aid in stabilizing the abutment. For possible areas requiring rock bolts see Photograph No. 13.

(c) Cofferdams: During inspection of the downstream cofferdam floodway structure, the undersigned discussed and recommended to project personnel that the impervious material softened by the rain, freezing and thawing, be removed before placing and compacting of additional required material to complete the structure.

(d) Inspection of the Contractor's Core Samples. After the group inspected and compared the design foundation grades with the new core borings, tentative grades were selected for construction excavation. (See Attachment 1 and representative Photograph Nos. 19 thru 24. The following changes were made to date

Monolith	Design Grade	Tentative Excavation Grade
1	1046	1045
2	1025	1022
3	997	995.6±
4	997	995.6±
5	989	987.4±

Founding elevations for monoliths 6, 7, 8 and 9 will be confirmed after detail logging of borings 202, 210 and 211. During the inspection of the above core samples, it was noted that a shear plane was encountered near elevation 990 (Monoliths 6, 7, 8 and 9) which may require the lowering of these foundations by several feet. Mr. Stu Long (ORPED-G) will log the core in detail and then he and Mr. Pat Oshel will determine the founding elevations after conferring with the Pittsburgh Structural Branch.

7. Conclusions:

(a) Core drilling and excavation of the right abutment are progressing satisfactorily. Core recovery is very good and samples are in [redacted] Contract drilling at present [redacted] confirmed the founding grades proposed in the design with only minor changes. It was agreed by the inspection party that the shear zone area should be examined in detail to insure that the plane does not daylight within the stilling basin before the founding grades are determined in Monoliths 6, 7, 8 and 9.

(b) Left abutment slide area at present does not appear to present a problem to the first phase construction or safety. However, it is recommended that horizontal control points located on the rock buttress be closely monitored for any movement. (See Photograph No. 7).

(c) Stress relief joints in the right abutment should be cleaned off and inspected to determine if rock anchors are needed for rock slope stability during construction.

8. Future Actions by the District.

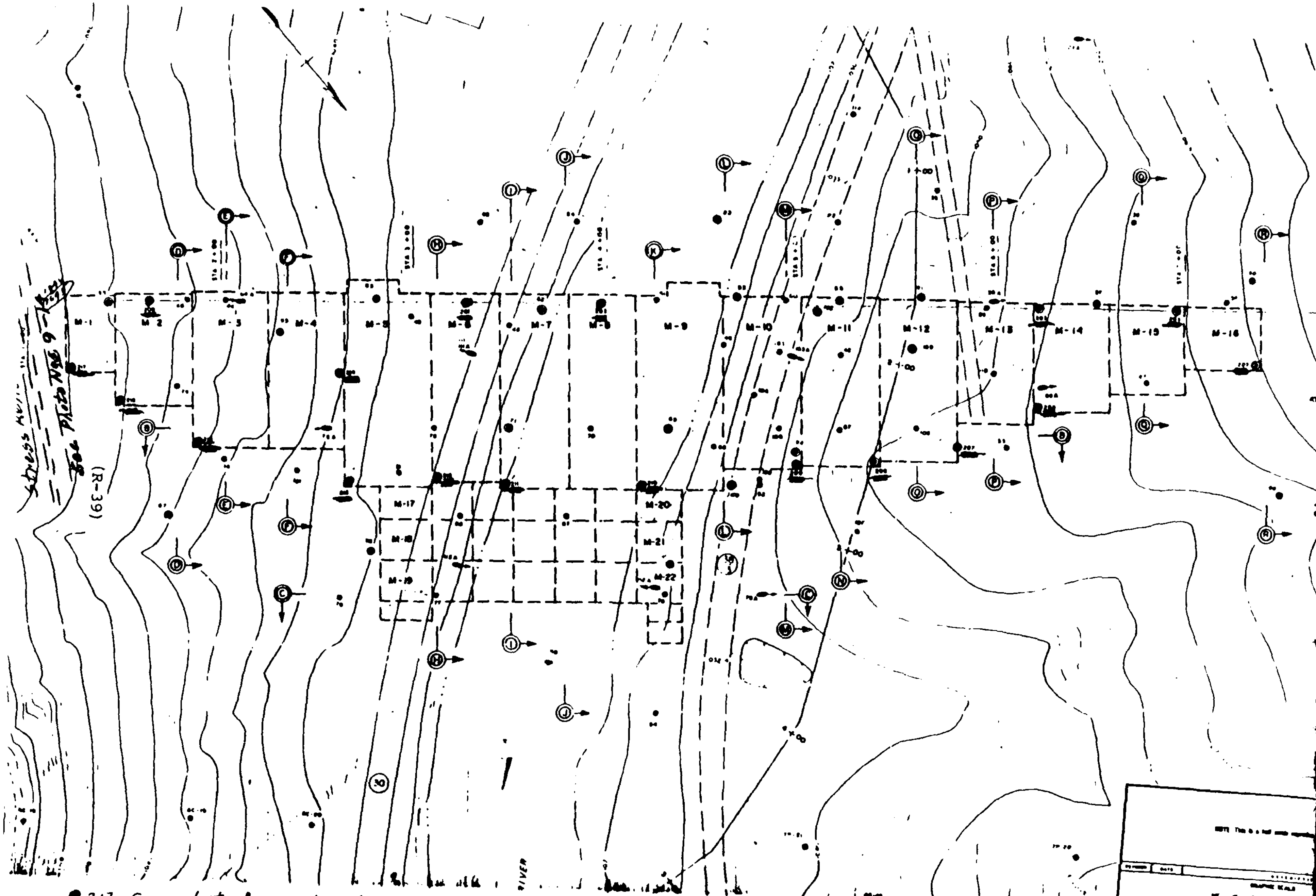
(a) Project Resident Engineer needs to have the contractor read and record any movements of the rock buttress control points. The readings should be reported to ORPED-G.

(b) Clay filled joints in the right abutment should be cleaned off and examined by Project and District personnel for possible rock bolt installation.

(c) Pittsburgh District (ORPED-G) will notify the Division (ORDED-G) when core drilling has been completed and schedule a meeting at the site for core sample inspection and grade selection.

9. The undersigned would like to express his appreciation to Pittsburgh/Huntington Districts and Project personnel for their efforts and cooperation in making this a very informative and productive site visit.

Charles G. Canning
CHARLES G. CANNING
Division Geologist ED-G



● 217 Completed Contract Borings

◎ 203 Proposed Contract Borings

Attachment No. 1

ORPED-G 15 March 1984

MEMORANDUM FOR RECORD

SUBJECT: Stonewall Jackson Dam Trip Report, Contract No. DACW59-C-83-0053

1. On 7 March 1984, Stuart Long, Chief of the Geology Section, Robert John, Geologist, and Sam Smith, Engineer in Training, all of the Pittsburgh District Geotechnical Branch, visited the Stonewall Jackson Dam site to check the field logs of borings being drilled to confirm design foundation elevations. Borings 202, 210, 211 and 212, representing Monoliths 6, 7, 8, and 9, were logged. (See attached location map.) The borings representing Monoliths 1 through 5 had previously been checked as noted in the 5 March 1984 Memo on the same subject.

2. The ORPED-G group was met at the site by Pat Oshel of the Huntington District Construction Division and David Nugen, the Project Geologist compiling the field logs. The following foundation elevations were agreed upon:

Monolith 6 - Elevation 987.4
Monolith 7 - Elevation 985.0
Monolith 8 - Elevation 985.0
Monolith 9 - Elevation 985.0

Only Monolith 6 represents a change from the original design - the foundation has been lowered 1.6 feet from the proposed foundation elevation of 989.0. This enables the foundations of Monoliths 5 and 6 to be kept at the same elevation and eliminates the need for a vertical step.

All four of the borings logged had a soft to moderately hard, slicken_sided and broken claystone zone at approximately elevation 989. While this is above final foundation grade for the monoliths, it may become important in terms of the passive resistance of the stilling basin foundation. Additional exploratory borings in the stilling basin area will be necessary to determine if this zone daylights immediately downstream of the end sill.

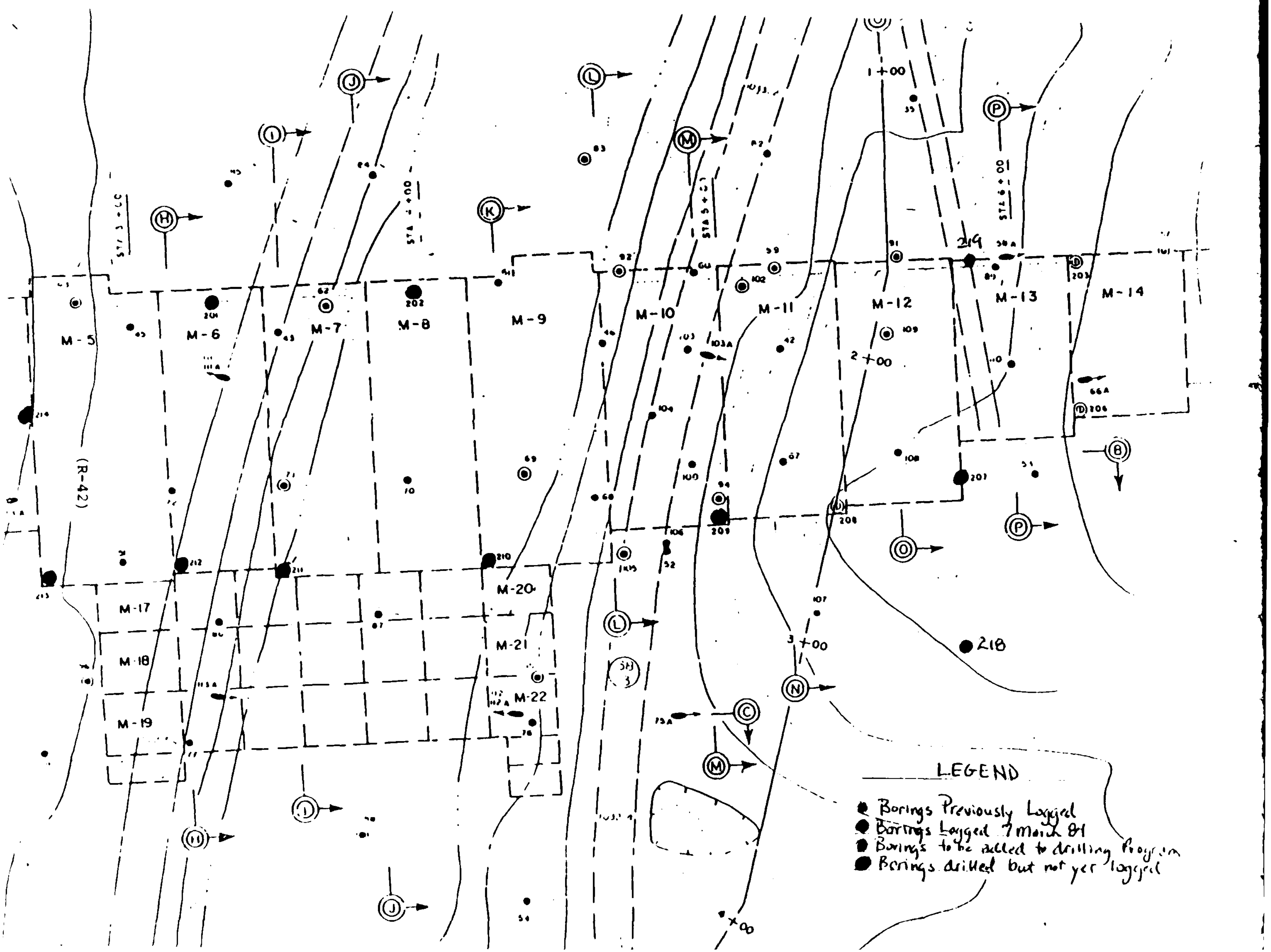
3. The cores from holes 209 (downstream left corner of Monolith 10) and 207 (downstream left corner of Monolith 12) were also available for inspection. The drillers had just moved from 207 that morning. Time constraints precluded a detailed examination of these borings, but problems were noted in both holes that will require further detailed investigation.

4. The bottom of the hole 207 was terminated at elevation 980, ten feet below the proposed foundation of Monolith 12. A soft clay gouge zone with claystone breccia is present from elevation 987.4 to 984.3 and below this is a sandstone unit featuring high angle diagonal fractures and shards of

sandstone in a soft clay matrix to elevation 980. Evidence of this gou zone can be found in the logs of neighboring borings. To better determ the extent of this feature, modifications to the drilling program were agreed on by Messrs. Long, Oshel, and William Woodburn, Resident Engine First, the drillers are to move back onto hole 207 and continue coring elevation 970. Second, two holes (218 and 219) are to be added to the drilling program at the locations shown on the map. The first hole is be at the upstream end of Monolith 13 landward of the diversion channel and the second is to be located 50 feet downstream of the downstream en Monolith 12 in line with the Monolith 12-13 joint. These two holes are also to be drilled to elevation 970. The gouge zone found in hole 207 makes it imperative that hole 208 be drilled in its original location, which is along the center line of the diversion channel. This drilling will have to be completed after second stage diversion is made.

5. Before returning to Pittsburgh, the procedure for installing horizo rock bolts in vertical faces was clarified. The Contractor proposes us resin grouted rock bolts rather than the mechanically anchored bolts li in the specifications. It was agreed that the depth to which these wil installed will be determined in the field, based on the joint pattern a condition of the rock.

Stuart B. Long
STUART B. LONG
Chief, Geology Section



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(R-42)
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2+00
3+00
STA 6+00
219
218
202
201
209
210
211
212
LEGEND
Borings Previously Logged
Borings Logged 7 March 84
Borings to be added to drilling Program
Borings drilled but not yet logged

ORPED-G 23 March 1984

MEMORANDUM FOR RECORD

SUBJECT: Stonewall Jackson Dam Trip Report, Contract No. DACW59-C-83-0053

1. Stuart Long, Chief of the Geology Section, and Robert John, Geologist, from the Pittsburgh District Geotechnical Branch visited the Stonewall Jackson Lake Dam site on 14 and 15 March 1984 to assess the progress of excavation and check the logs of borings being drilled to confirm final foundation elevations of the monoliths. Mr. Pat Oshel of ORHCD-I met us at the project. Meetings during two similar trips made within the last month had produced agreement on the final foundations for Monoliths 1 through 9 in the first stage cofferdam, based on examination of borings 200 through 202 and 210 through 217. (See memos on same subject dated 5 March and 15 March 1984.) The borings logged on this trip were 203, 206, 207 and 209 representing an area on the left abutment including monoliths 10 through 14 This is shown on the attached location map.

2. As noted in the memo of 15 March 1984, a cursory examination of Hole 207 done during the last trip showed a brecciated and gouged zone from 986.4 (incorrectly indicated as 987.4 in the memo) to what was then the bottom of the hole at 980.0. As requested, the drillers subsequently moved back onto the hole and deepened it, the final bottom of hole elevation being 971.4. The detailed log of this boring indicates this zone consists of a soft, broken, dark gray claystone from 986.4 to 983.7 overlying a highly fractured and sheared, fine grained, moderately hard sandstone from 983.7 to 980.0. There is very little competent rock in the upper claystone unit - for the most part the claystone exists as brecciated fragments in a soft, gray clay matrix. The sandstone unit exists as sheared fragments of the parent material, occasionally suspended in a clay matrix (at elevations 982.4 and 981.3). A 1.2' core loss was present in the run going through this sandstone and was assigned elevation 981.2 to 980.0. The additional drilling requested in this hole indicates the gouged, brecciated zone ended at elevation 980. The remainder of the boring was a series of moderately hard siltstones and shales.

3. Boring 209 at the downstream left corner of Monolith 10 contained the same thin claystone zone at approximate elevation 990 that has appeared in other borings. This unit is soft, highly factured and slickensided and contains some evidence of gouge. It is above the proposed Monolith 10 foundation elevation of 987.0. A reddish brown, slickensided indurated clay which is a marker bed in the area was found at the bottom of this hole, from 971.4 to 970.0.

4. Borings 203 and 206, at the upstream and downstream ends of the Monolith 13-14 joint respectively, contained primarily sandstone with zones of claystone and siltstone. A founding elevation of 1027 is being considered for Monolith 14. The sandstone below this elevation in Hole 206 is in excellent condition while in Hole 203 there are some high angle to vertical joints with rust staining that will require treatment. It is apparent that the vertical step between Monoliths 13 and 14 will be primarily this sandstone although the final elevation of the Monolith 13 foundation has not been determined.

5. Drilling had not yet begun on borings 218 and 219, which have been added to the drilling program to better determine the extent and characteristics of the gouge and breccia zone found in Hole 207. It was decided by Messrs. Long and Oshel that Hole 218 would be moved upstream 25' to a location 25' downstream of the corner of Monolith 12. There had been some concern that the seam would daylight within the original 50' and the desired information would not be obtained. In Hole 219 core shall be retained from elevation 1023 to 970, while in Hole 218 core is to be retained from the top of rock down to elevation 970. The final location of Hole 219 is on the axis of the dam 2.5' landward of the Monoliths 12-13 joint to allow for working room along the diversion channel.

6. As mentioned in the 15 Mar 84 memo, the conditions found in Hole 207 make it imperative that Hole 208 be drilled at its planned location. Messrs. Long and Oshel agreed that it would be desirable to drill this hole now and get the information as soon as possible, rather than waiting until the second stage diversion is made. A platform across the diversion channel will be needed and it is recommended that 6" casing be drilled securely and grouted into the bottom of the channel prior to drilling. Mr. Hamric, field engineer at the project, agreed to work out the details with the contractor. The difficulty of drilling this hole over water will result in a possible change to the contract, however, the value and timeliness of the data justifies the added expense.

7. Mr. Long decided that adding two holes at the downstream end of the stilling basin, to be numbered 220 and 221, would be required (see attached location map). They will be drilled at approximately Stations 3+30 and 3+94 at a distance 5' downstream of the line drilled face of the end sill. Their purpose is to determine if the 0.5' thick claystone seam at approximate elevations ranging from 987.5 to 990.0 in holes 209 through 213 daylights downstream of the dam or remains at a fairly constant elevation. These two holes are to be core drilled from the top of rock to elevation 980.0.

8. The installation of rock bolts along the outside perimeter of Monolith 1 excavation was observed. Two rows of vertical bolts were being installed on 5' centers and stressed to 50 kips and short bolts on 2' centers were

being installed vertically and horizontally to anchor the wire mesh protection. Some of the long bolts could not be stressed to the full 50 kips, especially in shaly/indurated clay areas. It was proposed by Messrs. Long and Oshel that, from now on, the horizontal bolts should be installed more selectively on nonvertical excavations. There may be trouble with the drilling for the surface grouting to be done to the right of Monolith 1 due to the presence of the horizontal bolts already installed.

9. Mr. William Woodburn, Resident Engineer, joined the group while inspecting the dam excavation for a discussion of conditions in the area of the right abutment concrete tie-in and service road. Firm rock apparently drops more quickly than originally thought and it would seem that portions of the road will be founded on overburden rather than rock if built as it was designed. Messrs. Woodburn and Hamric would like to have this service road realigned, possibly using the current alignment of the contractor's access road. This proposal is to be reviewed by those who designed the road.

10. Final foundation elevations for Monoliths 10 through 16 in the second stage cofferdam will be determined after completion of the drilling program and analysis of the orientation and characteristics of the gouge and breccia zone found in Boring 207 and others.

11. The next inspection is scheduled for the week of 26 March 1984.

Stuart B. Long

2 Incl
as

STUART B. LONG
Chief, Geology Section

ORPED-G 5 April 1984

MEMORANDUM FOR RECORD

SUBJECT: Stonewall Jackson Dam Trip Report, Contract No. DACW59-83-C-0053

1. Reference Memoranda on same subject, dated 5, 15, and 23 March 1984.

2. Stuart Long, Chief of the Geology Section, and Robert John, Geologist, from the Pittsburgh District Geotechnical Branch visited the Stonewall Jackson Lake Dam site on 27 and 28 March 1984 to assess the progress of excavation and check the logs of four-inch borings being drilled to confirm final foundation elevations. As before, Pat Oshel of ORHCD-I met us at the project. The borings logged on this trip were 219, 220, and 221.

2. In order to take advantage of the good weather on the 27th, the group inspected the right abutment excavation shortly after their arrival. Presplitting and production blasting for Monolith 1 excavation has been completed to within approximately one foot of final foundation grade. The downstream end of the right side of Monolith 2 has also been presplit to this level. The rock faces exposed indicate a good blasting program yielding entirely satisfactory results. The chain link protective fabric required by the contract was being installed on the right side of Monolith 1 when we were there. Two workers located on an enclosed platform suspended from a crane were assisting in the installation.

3. As mentioned in the memo of 23 March 1984, borings 220 and 221 were added to the drilling program at the downstream end of the stilling basin, five feet downstream of the end sill. These borings were added to determine the orientation of a soft, slickensided claystone seam up to 0.5-foot thick relative to dam and stilling basin foundation elevations. There had been some concern that this seam would daylight just downstream of the dam, but these borings confirm that it remains at a fairly constant elevation throughout the spillway and stilling basin areas, ranging from 987.0 to 990.0. Competent rock units lie on both sides of this claystone unit, and the claystone seems to pose no threat to stability. It is expected that the final foundation of the stilling basin will be close to the originally planned 998.0. Design engineers will be consulted as to whether they would prefer lowering the foundation of the end sill key from 992.0 to below the claystone seam.

4. Hole 219 was one of the borings added to the drilling program to better determine the extent of the gouge and breccia zone found in boring 207 from elevation 986.4 to 980.0. Hole 219 is approximately 75 feet upstream of Hole 207, both being located on the landward edge of Monolith 12 (see attached location map). Hole 219 was cored from elevation

1023.3 to 970.0 and showed no evidence of the same type of gouge and breccia that was found in 207. However, there was a gouge zone at the very bottom of the hole from 970.5 to 970.0 in an indurated clay unit. An interesting discovery in Hole 219 was the presence of grout in a broken up portion of a claystone unit from elevation 991.4 to 990.9.

5. Hole 218 was still being drilled at the time of the visit. Apparently there was some misunderstanding as to its location, and it was laid out 25 feet downstream of Hole 207, rather than 25 feet downstream of the corner of Monolith 12 as it was supposed to be. This location places it approximately 17 feet downstream of the corner of the monolith. This boring will be logged on the next visit to the dam site.

6. The Contractor has excavated work areas in the left abutment at the locations of Holes 204 and 205, but as yet these holes have not been started. Unless bad material is found at the bottom of the hole, they are to be drilled to the depths originally indicated.

7. William Woodburn, Resident Engineer; William Hamric, Field Engineer; and David Nugen, Project Geologist, joined the group for discussions on founding elevations and excavation procedures. The first topic discussed was the stilling basin excavation. Line drilling at the downstream toe of the spillway monoliths is being done at the present time. The current level of excavation in the slab area is not far from final proposed foundation grade. Mr. Woodburn proposed that this area be cleaned up and then covered with a few feet of shot rock so that the stilling basin foundation will be protected while construction machinery is passing over it. Presplitting of the stilling basin slab itself is not envisioned; it is assumed only ripping equipment will be necessary. The foundations for the training walls will require presplitting, however, and this should be done before the area is covered with the shot rock. After checking the logs of pertinent borings, Mr. Long and Mr. Oshel agreed on founding elevations of 996.8 for Monoliths 20, 21, and 22 of the left training wall and 997.3 for Monoliths 17, 18, and 19 of the right training wall. The final elevation of the key at the end sill of the stilling basin will be determined after a discussion with Design Branch.

8. The distinction between preliminary and final foundation cleanup and inspection was discussed. It was agreed that preliminary cleanup would be done without air or water jets over the entire foundation when the expected grade is reached. Following inspection for major defects, the foundation would be covered with plastic and sand as previously agreed on. When the Contractor is ready to pour concrete, the sand and plastic would be removed and the final foundation cleanup with air and water jets, picks, brooms, etc. would be performed. This inspection would be much more detailed than that done for the preliminary inspection. It is intended that foundation cleanup would be paid for only once since the cost of preliminary foundation cleanup is included in the contract price for overlying excavation.

ORPED-G 5 April 1984
SUBJECT: Stonewall Jackson Dam Trip Report, Contract No. DACW59-83-C-0053

9. The epoxy coating specified in the contract to protect argillaceous surfaces in the excavation is being applied on a trial basis on the landward side of Monolith 1 excavation. The material being used is Celtite 42-51 Hi-Seal epoxy resin emulsion, a water based material with 30% solids. The chain link fabric is being installed at such a rate that the coating must be applied through it. No immediate problems are evident with this procedure, but its effectiveness will be monitored. The other faces of the excavation are not being covered at the present time due to water running over them.

10. The next visit is scheduled for the week of 9 April 1984.

1 Incl
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STUART B. LONG
Chief, Geology Section

CF:
ORPED
ORPED-G
ORPED-D
ORHCD-I
Resident Engr, Stonewall Jackson Lake
ATTN: ORHCD-Liaison

ORPED-G 19 April 1984

MEMORANDUM FOR RECORD

SUBJECT: Stonewall Jackson Dam Trip Report, Contract No. DACW59-C-83-0053

1. Reference Memoranda on same subject, dated 5, 15, and 23 March and 5 April 1984.

2. Stuart Long, Chief of the Geology Section, and Robert John, Geologist, from the Pittsburgh District Geotechnical Branch visited the Stonewall Jackson Lake Dam site on 10 and 11 April 1984 to inspect the progress of excavation and to check the logs of four-inch borings being drilled to confirm final foundation elevations. As before, Pat Oshel of ORHCD-I met us at the project. The borings logged on this trip were 204, 208, and 218. (See attached location map).

3. Because of apparent discrepancies, a survey crew was brought in to determine the exact locations of Holes 207 and 218 relative to the axis of the dam. As drilled, hole 207 is 65 feet downstream of the axis and hole 218 is 85 feet downstream of the axis. The original layout placed these holes 70 feet and 105 feet downstream of the axis, respectively; but a misunderstanding resulted in Hole 218 being offset from hole 207 rather than the corner of the monolith. Neither hole 208 nor 218 showed evidence of the thick gouge and breccia zone found in Hole 207 from elev 986.3 to 980.0.

4. Based on available boring data, Mr. Long and Mr. Oshel tentatively agreed on the following foundation elevations:

Monolith 10	Elev 987.0
Monolith 11	Elev 987.0
Monolith 14	Elev 1027.0
Monolith 15	Elev 1039.7

The upstream end of monolith 11 may require some special treatment due to the presence of a clay and breccia zone found in boring 59 from elevation 988.4 to 986.0. Founding elevations for Monoliths 12 and 13 were discussed but no decision was made. This area is probably the most geologically complicated area at the site with frequent discontinuous shear zones and soft areas. A more detailed study of this area will be required before final decisions on foundation elevations can be made.

5. From the left abutment, the group observed rock blasting on the right abutment in the area of Monolith 2. The Contractor followed all the required safety precautions and the shot itself was properly executed.

6. The second day of the visit included inspections of the left and right abutments and the area inside the first stage cofferdam. Recent spring rains have increased the sliding problem on the left abutment. The slides in the sloping areas above the rock buttress continue to worsen, and the buckling of the gravel blanket has progressed to the point that there is an approximate 5 foot scarp between the horizontal surface of the buttress and the overburden above it. Inspection of the left abutment area above and downstream of the buttress indicates the possible start of other slides with recent ground separations evident along a line roughly parallel to and above the dirt road leading up behind the top of the slope above the buttress. The downstream extent of the potential slide area is approximately Station 19+00, near the upstream end of the paved section of the access road. Many areas within this zone are saturated and show fresh tension cracks and numerous new seeps. Conditions on this abutment should be monitored frequently in the coming months.

7. Work is progressing well within the first stage cofferdam in the area of the former river bed. Excavation by earth-moving equipment is continuing and the coal is being stockpiled and removed to the approved disposal area. The left side of this area, a rock face corresponding to the right side of the diversion channel, is geologically complicated with many small scale folds and crushed areas present in the claystone and siltstone units between the sandstone at the top of the cut and the coal at the bottom. A survey crew at the site provided elevation readings on the top of coal at intervals along this face. In the diversion channel itself there is evidence of cracking of the gunite, and on the left side high water has caused some erosion of the indurated clay above the gunite.

8. On the right abutment, Monolith 1 excavation is nearly complete. The Contractor had crews cleaning up the foundation with water jets and shovels, after which Mr. Long and Mr. Oshel conducted a preliminary inspection of the surface. The landward side of the monolith and the corners will have to be lowered approximately 1 1/2 feet to get below the red indurated clay and into the underlying silty sandstone. There is a thin clay seam separating these two units and the foundation must be below this seam. Aside from the need for minor excavation and the presence of loose and drummy rock in some places the foundation appeared good. High angle, rust-stained joints running parallel to the valley are fairly common in this part of the abutment, and their traces can be seen in the side walls as well as the floor of the excavation. These joints may require some dental treatment prior to final foundation approval. It was recommended that the Celtite protective

RPED-G 19 April 1984

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covering be applied soon to the argillaceous surfaces due to the reduced quantity of water running down the sides of the excavation now.

9. Of the exploratory borings, only No. 205 remains to be drilled. The next visit is planned after this hole is completed.

Stuart B. Long

1 Incl
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STUART B. LONG
Chief, Geology Section

ORPED-G 11 May 1984

MEMORANDUM FOR RECORD

SUBJECT: Stonewall Jackson Dam Trip Report, Contract No. DACW59-C-83-0053

1. Reference Memoranda on same subject dated 5, 15, and 23 March and 5 and 19 April 1984.

2. Stuart Long, Chief of the Geology Section, and Robert John, Geologist, from the Pittsburgh District Geotechnical Branch visited the Stonewall Jackson Lake Dam site on 2 and 3 May 1984.

3. On 2 May the dam site was the location of a meeting of the Allegheny-Ohio Chapter of the Association of Engineering Geologists and the American Institute of Petroleum Geologists. The meeting was coordinated by Pat Oshel, ORHCD-I. The group of approximately 40 heard a presentation on the overall project by Mr. Bill Woodburn, Resident Engineer, followed by a talk dealing specifically with the geology of the Weston area and the dam site presented by Mr. Long. The group then toured the site. At this time the foundation for Monolith 2 had been excavated approximately to grade and significant progress had been made in the area of the spillway monoliths in the former river bed, in addition to progress mentioned in previous memos. Group members seemed very appreciative of the opportunity to view foundation preparation procedures for a concrete gravity structure.

4. Preliminary foundation inspection of the Monolith 2 foundation was conducted on 3 May by Messrs. Long, Oshel, Hamric (Field Engineer at the Project), and representatives of the Contractor. This monolith will be founded in a moderately hard sandy siltstone. There are some high angle joints and shears that can be traced down the side walls and across the floor of the monolith, similar to those noted in Monolith 1. (See attached drawing) These joints trend approximately N 29° E and are especially prevalent on the riverward side of the monolith. Workers were cleaning off the foundation with water jets and much of the rust stained and broken material within these joints was being removed. This leaves an irregular surface on the riverward side that will require treatment with dental concrete. In addition, Mr. Long proposed the installation of inclined rock bolts along the top of the Monolith 2/3 vertical cut to stabilize the face against any possible weakness caused by the jointing.

5. Two ungrouted six-inch core borings were found in the upstream right corner of the monolith floor. One of these is presumably Boring 65, drilled in 1972. This boring should have been located in Monolith 1. The field book for this hole shows a grout take of only three bags, indicating a blockage of some sort occurred near the top of the hole and it was never fully grouted. It is not known why there are two borings within six feet of each other. The Contractor has been directed to grout both of these borings.

ORPED-G 11 May 1984

SUBJECT: Stonewall Jackson Dam Trip Report, Contract No. DACW59-C-83-0053

6. Excavation within the cofferdams for the spillway monoliths is proceeding well. The line drilling done at the downstream toe of these monoliths looks excellent. Monolith 9 has been drilled and blasted to grade, but the area is still covered with the blasted rock. Drilling and blasting are proceeding toward the right abutment. Water is entering the Monolith 9 area from two locations at the base of the coal, which has been shotcreted. The source of the water is from the diversion channel. At the present time the one pump is adequate to remove this seepage.

7. The core from hole 205 was examined by Mr. Long to confirm the project geologist's logging. This was the final boring drilled under the contract drilling program and represents the foundation in the downstream left corner of Monolith 16. (See attached location map) Nothing unusual or unexpected was encountered and the log corresponds very well with the log of Boring 56 at the upstream center of the monolith. Based on these two borings Mr. Long and Mr. Oshel tentatively agreed to raise the foundation elevation two feet from 1058 to 1060 near the top of a silty sandstone unit. Beginning approximately at elevation 1056.5 is a moderately hard, compact, red claystone unit approximately seven feet thick.

8. At a meeting prior to returning to Pittsburgh, Mr. Hamric raised questions about the location of the grout nipples in the gallery. With the exception of the abutment fans, the grout holes are to be drilled 20° upstream and 20° toward the abutment from the gutter of the drainage gallery. Mr. Hamric pointed out that at their designed location six inches from the upstream face of the gutter, it will be physically impossible to drill some of the holes due to the height of the downstream wall of the gutter, which reaches a maximum depth of 20 inches in Monolith 8. Mr. Hamric suggested moving the center of the grout holes to a position two inches from the upstream wall rather than six inches. Subsequent recalculations in the Geotechnical Branch indicate this would alleviate the problem. To attain the desired inclination, the holes should be drilled downward at a 27° 20′ angle from vertical along a plane 45° from the downstream face of the gutter. With the center of the hole two inches from the upstream wall, the holes can be drilled so long as the gutter is less than 23 inches deep. Mr. Hamric also suggested that the collars be set at least 1/2 inch below the gutter floor to prevent staining.

Stuart B. Long

2 Incl
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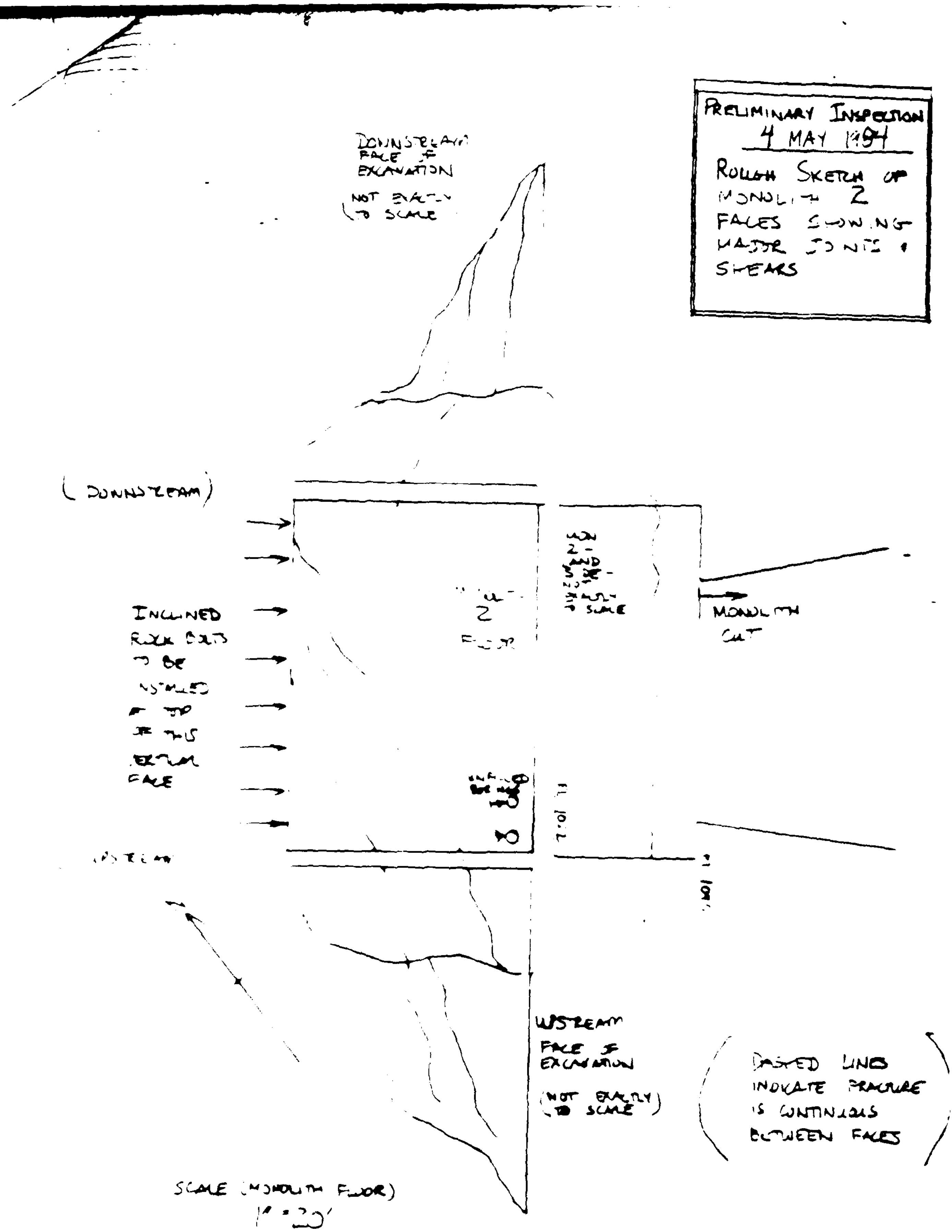
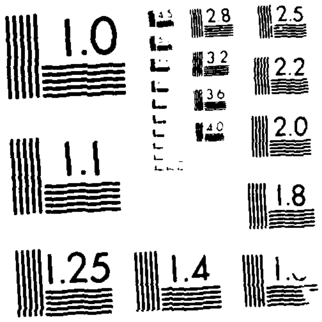
STUART LONG
Chief, Geology Section


PRELIMINARY INSPECTION
4 MAY 1984
ROUGH SKETCH OF
MONOLITH 2
FACES SHOWING
MAJOR JOINTS &
SHEARS
DOWNSTREAM FACE OF EXCAVATION
(NOT EXACTLY TO SCALE)
(DOWNSTREAM)
INCLINED ROCK BOLTS
2
MONOLITH CUT
UPSTREAM FACE OF EXCAVATION
(NOT EXACTLY TO SCALE)
DASHED LINES INDICATE FRACTURE IS CONTINUOUS BETWEEN FACES
SCALE (MONOLITH FLOOR)
1" = 20'

AD-A191 144 FOUNDATION REPORT ON STONEWALL JACKSON DAM WEST FORK RIVER BASIN WESTON W... (U) CORPS OF ENGINEERS HUNTINGTON WV HUNTINGTON DISTRICT D NUGEN 21 DEC 87 4/6

UNCLASSIFIED DACW59-83-C-0053 F/G 13/2 NL



MICROCOPY RESOLUTION TEST CHART

ORPED-G 23 May 1984

MEMORANDUM FOR RECORD

SUBJECT: Stonewall Jackson Dam, Trip Report, Contract No. DACW59-C-83-0053

1. Marshall Fausold (ED-G), Charles Stevenson (ED-GS), and John Gribar (ED-DM) visited the Stonewall Jackson Dam on 16 May 1984. The purposes, besides that of a general progress inspection, were to inspect the condition of the Dam Access Road, assess the state of the landslide above the left abutment, and review procedures for bringing the concrete batch plant to operational status. Personnel at the site participating in the visit activities in whole or in part were Bill Woodburn (Resident Engineer), Red Searick, Rodney Young (all ORHCD-SSJ), and Pat Oshel and Milt Christensen (both ORHCD-I). Photos taken are attached.

2. The Dam Access Road was walked. Considerable soil fines had been deposited by vehicular traffic on the surface of the aggregate base course over the preceding winter. Shallow test pits were dug at six locations to determine the depth of contamination. This depth appeared to reach a maximum of 1-1/2", and was more typically 3/4". Several apparent deficiencies were also noted. Among these were that the required removal and replacement of pre-existing paving between Station -1+16 and approximate Station 3+00 had not been accomplished, and that required guardrail between Station -1+00 and approximate Station 0+00 had not been installed. The Project personnel were reminded of the DF, ORPED-G, subject: Bituminous Paving - Dam Access Road, dated 1 December 1983, and the Pittsburgh District's desire to have the road paved without any further delay was emphasized. Because of the base course contamination discussed above, a result of the prime contractor for the access road being unable to complete the work in the fall of 1983, it will now be necessary to strip and waste the upper 2.0" of existing base course. After such removal, the existing base course should be scarified to a depth of 3", the removed 2" replaced with new material, and the whole recompacted according to specifications prior to proceeding with asphalt paving. It was noted that the prime contractor had been released several months ago, but no final inspection had been held.

3. The left abutment landslide and rock buttress were walked. The hill or rear side of the buttress had been partially heaved up by the pressure of the soil it retained, but no indication of displacement of the buttress as a whole was observed. Numerous slide scarps were observed both in the graded slope above the buttress and in the undisturbed slope above and to the northwest of the graded slope. Water was observed seeping from several

points distributed about the affected area, although the quantity was reported to have decreased in the two weeks since Mr. Stevenson had previously observed it. The extent of sliding at the highest point on the hill was about 40 feet downhill from the alignment of a commercial power line, but was about midway between supporting poles. No threat to the power line is anticipated for the remainder of this year at least. Although there are numerous cracks and scarps in the upper portion of the slide in the ungraded area, these narrow and disappear as one progresses down the slope. Where the slide area is crossed by the last 50 feet or so of access road "2", a shallow cut slope which intersects the bedrock-overburden contact shows no indications of movement except for a small slough believed to be unrelated to the major movement. The slide is not expected to develop significant further movement during this construction season, although an unusually wet summer could reactivate it. Remedial measures may include installation of a system of subsurface drainage and minor grading to close cracks and scarps. Such work cannot be initiated until late summer after appreciable natural drying has occurred. The decision as to whether or not to implement such measures may be delayed at least until July or possibly even until the second construction season on the dam.

4. The cofferdams appeared in generally satisfactory condition, except that, although over five months had elapsed since their effective completion, the slush grouting of the surface stone still had not been accomplished. It was noted that a minor low area had been created in the crest of the upstream cofferdam to permit vehicle access across it. The cofferdam foundations appeared exceptionally dry, with minimal seepage entering along a horizontal seam about three feet below top of rock below the upstream cofferdam. No seepage was noted entering through the overburden foundation of the righthand portion of the upstream cofferdam. Most of such infiltration as was occurring was entering along the base of the coal seam at the bedrock block between the Phase I dam excavation and the diversion channel. Total pumping discharge from the excavation was roughly judged as about 100 GPM.

5. Excavation for the dam itself was well underway. We witnessed the final shot on Monolith 7. Only Monoliths 5 and 6 have not been shot to grade. Mass excavation for Phase I of the dam may be complete by 18 May. Only the foundations for Monoliths 1 and 2 have had preliminary cleaning and approval as of this date. Mass excavation for the stilling basin was likewise complete, with cleanup in progress. Foundations for initial monoliths of the training walls are expected to be ready for final approval during the week of 20 May. The concrete batch plant status was reviewed. A general shake down and adjustment of the plant is proceeding. The scales'

operating performance was being checked during our visit. Aggregate stockpiles on site consisted only of samples stored off the concrete pads recently poured for storage of production aggregates. All size gradations were represented. On the basis of visual examination of the material present, an impression was formed that the percentage of flat/elongate particles may exceed allowable limits in the 3" and 1-1/2" max piles. A sample will be secured from production stockpiles at the quarry by Geotechnical Branch personnel at the next opportunity, and sent to ORDL for a "count". Mr. Woodburn stated that three wells had been drilled for concrete mixing water, but that one had evidently collapsed. The Contractor's intention is to use the remaining wells for reserve supply and to obtain both mixing and washing water from a large diameter gravel-packed well at the river's edge. The ice plant is now functional.

6. The requirements for concrete testing prior to declaring the batch plant operational for production were reviewed. The requirements of the Specification Sections 3D10.3 and 3D16.2.11 concerning mixing tests were noted and the intention of the Pittsburgh District that they be fulfilled was emphasized. Also specifically noted was the required seven day delay subsequent to completion of operability testing, and the necessity of obtaining cylinders for a seven-day record break. All ORHCD personnel objected to these requirements very emphatically, but agreed to comply subject to conversations with ORD.

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MARSHALL FAUSOLD
Chief, Geotechnical Branch

CF:

ORPED-DM (w/o photos)
ORHCD-L (w/o photos)
ORDED-G (w/o photos)

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ORPED-G 11 June 1984

MEMORANDUM FOR RECORD

SUBJECT: Stonewall Jackson Dam Trip Report, Contract No. DACW59-C-83-0053

1. Reference Memoranda on same subject dated 5, 15, and 23 March, 5 and 19 April and 11 May 1984.

2. Stuart Long, Chief of the Geology Section, and Robert John, Geologist, from the Pittsburgh District Geotechnical Branch visited the Stonewall Jackson Lake Dam site on 24 and 25 May 1984 for the primary purpose of inspecting monolith foundations at the site.

3. Preliminary foundation inspections had previously been conducted for Monoliths 1 and 2. At the time of this visit, Monoliths 3 through 9 had been shot to grade but were not sufficiently cleaned to allow for a preliminary inspection. The floor of Monolith 3 was partially covered with water entering through the coal seam exposed approximately one to two feet above foundation grade. A similar situation was found in Monoliths 7, 8, and 9 due to water entering the excavation from below the coal in the rock block adjacent to the diversion channel. The siltiness of the foundation rocks promotes a tendency to crumble when exposed to wetting and drying cycles so it is recommended that once preliminary inspections are performed the surfaces be protected as soon as possible. There is to be an approximately two-foot high vertical step between Monoliths 6 and 7, but it appears this surface is quite irregular and the step may have to be specially formed for a "plug" pour.

4. The Contractor has excavated and graded overburden materials on the left abutment below the rock buttress. This exposed a thick indurated clay seam in the newly excavated slope below the base of the rock buttress. While this condition seems to pose no threat to the stability of the buttress at the present time, examination of material on the slope indicates that the indurated clay deteriorates rapidly when exposed. Mr. Long requested that this indurated clay unit be shotcreted soon to prevent it from weathering back into the hillside, which would endanger the stability of the rock buttress.

5. It was also recommended that the Redstone Coal exposed by the Monolith 3 excavation be given additional protective coatings. This coal is up to five feet thick in places. The three sides of the excavation have already been coated once with the Celtite 42-51 Hi-Seal Epoxy Resin and Emulsion and Mr. Long recommended that they be coateu two more times.

ORED-G 11 June 1984

SUBJECT: Stonewall Jackson Dam Trip Report, Contract No. DACW59-C-83-0053

6. The Contractor intends to place the first concrete at the project in Monolith 21 of the left training wall. Concrete testing of sample batches is required prior to declaring the batch plant operational and at the time of the visit these tests were being conducted by personnel of the Huntington District and Charles Stevenson of this office. We observed the Contractor constructing the form work for Monolith 21 and Monolith 22 in addition to examining the foundation of Monolith 21 in its current state prior to final foundation clean-up. The foundation appears to be in generally good condition in a sandy siltstone unit but will require removal of some drummy rock and loose pieces. A portion of the left end of the shear key has been excavated and the results are good. The key extends approximately six feet within the framework being set up for Monolith 22 and will eventually extend across the width of the stilling basin into Monolith 19 of the right training wall.

7. Additional trips are planned for viewing preliminary or final foundation clean-ups.

STUART LONG
Chief, Geology Section

ORDED-G 11 June 1984

MEMORANDUM FOR THE RECORD

Subject: Trip Report, Stonewall Jackson Dam Safety Meeting, Inspection of Foundations and Concrete Aggregate Source.

1. On 30 May thru 1 June 1984, the undersigned inspected Monoliths 3, 4, 5, 6, 7, 8 and 9 foundations and the J.F. Allen Quarry. See Attachment 1 for Agenda.

2. Purpose:

(a) attend Dam Safety meeting
(b) inspection of Phase I foundations of Monoliths 3-9
(c) examine Phase II core boring samples
(d) inspect J.F. Allen Quarry

3. Attendees:

(a) For Dam Safety meeting attendees see Attachment 2.

(b) The following attendees continued inspection of the foundations and core samples on 31 May.

Mr. Stu Long, Chief of Geology, ORPED-GG
Mr. Pat Oshel, Geologist, ORHCD-I
Mr. Bill Woodburn, Resident Engineer, ORHCD-SWJ
Mr. David Nugen, Project Geologist, ORHCD-SWJ
Mr. Red Hamric, Chief of Inspection, ORHCD-SWJ

4. Background: During the visit of 27 and 28 February 1984, the undersigned inspected the core samples, drilled by the contractor,to select founding grades for construction of Phase I monoliths 1 through 9. (Reference MFR, 14 March 1984). The purpose of this trip was to inspect tha uncovered foundation rock and the J.F. Allen quarry.

5. Observations:

(a) On the morning of 30 May, Dam Safety group arrived at the resident's office for a briefing before proceeding to the site. Upon completion of the briefing the group inspected the site. Monoliths 3 through 9 have been excavated to near foundation grade and the contractor was beginning foundation preparation in Monolith 9. During the inspection it was noted that a bedding plane at the founding elevation of monolith 7 and approximately 1.5 to 2 feet below Monoliths 5 and 6 appeared to be open. See photograph 1. If this proved to be the case both Monoliths 5 and 6 would have to be lowered. Also a shear zone was quite evident at approximately elevation 989 in the

downstream wall of Monoliths 5 through 9. See photographs 2, 3 and 4. This shear zone had been noted in borings 210, 211, 212 during the 27 and 28 February inspection. During the February visit it was decided to drill two additional borings in the spillway to determine the attitude of the shear plane. These borings indicated that the plane had a very slight dip downstream and did not daylight in the spillway area. See photographs 10 and 11. This shear plane is also under Monoliths 4 which is founded at elevation 995.6. The rock behind most of this monolith from elevation 995.6 to approximately 1010 had been removed thus making a surface founding monolith. See photograph 12. The party inspected the near vertical rock cuts in Monoliths 2 and 3. See photographs 13, 14 and 15. Photograph 15 may explain why correlation of the coal seam was difficult in some of the areas during design.

(b) After lunch the group discussed the inundation and warning plans, filling plan and the site inspection. Mr. Armstrong (ORDED) expressed concerns on the stability of Monolith 4 since it will be founded above the shear zone and the downstream rock behind it had been removed. Mr. John Gribar (ORPED-DM) stated that stability analysis had been run at the concrete/rock contact and the downstream rock was not needed. Also since the shear zone located some eight (8) feet below the founding elevation dips slightly downstream, the deep seated stability analyses also proved stable. However, Mr. Gribar stated that he would check the calculations and phone Mr. Long on 31 May 1984. The undersigned stated that the existing core boring samples would be reviewed to determine the D/S attitude at the shear zone and the condition of the bedding plane under Monoliths 5 and 6. Based on these findings and Mr. Gribar's telephone call, a decision would be made on the founding elevations of Monoliths 4, 5 and 6. The Dam Safety meeting was then adjourned.

(c) On May 31, 1984, the undersigned met with Mr. Long (ORPED GG), Mr. Oshel (ORHCD-I) and Mr. Nugen (ORCDC-SWJ) to examine core samples from borings behind Monoliths 4, 5, 6, 7 and 8 and the borings in Phase II construction. The following are the results of the examination of borings located downstream of Monoliths 4 through 9. For locations, see Attachment 3.

Boring No.	Monolith No.	Founding EL.	Shear Zone	Photo No.
210	9	985	989±	5
211	7	985	989±	6&7
212	5&6	987.5	989±	--
220	End Sill	996.8&992	986±	10&18
221	End Sill	996.8&992	987.6	11
*101	4	995.6	987.2	--
* 96	4 & 5	995.6 & 987.5	986±	--

*Note reviewed boring log only.

Based on the above borings and exposures in the excavation, it w determined that the shear zone dips slightly downstream toward the right abutment. The 8 to 9 feet of rock above the zone appears to be competent. See Photographs 2, 3, 5, 8, 10, 11 and 18.

(d) Core samples from boring 201, 214, 213, 212 and 211 wer examined to check condition of the bedding plane under Monolith 5 & 6, since it appeared to be open at the joint between Monoliths 6 and 7. See Photograph 1. The bedding plane indicated no weathering, soft material or openings. See Attachment 3 for boring locations.

(e) Borings in the second phase contract were examined by the group. These borings were drilled by the contractor to confirm the selected design grades. Several borings in Monoliths 13, 14, 15 and 16 encountered shear zones indurated clay beds and stress relief joints. To check the rock conditions downstream of Monoliths 12 and 13 Boring No. 218 was drilled. See photographs 19 through 28. As of this date final grades have not been established.

(f) June 1, 1984, the undersigned accompanied Mr. Hugenberg (ORDED-G) and Mr. Stevenson (ORHED-G) for an inspection of J.F. Allen quarry.

6. Discussion:

(a) Monolith 4: Mr. Gribar (ORPED-DM) telephoned Mr. Long (ORPED-GG) the afternoon of 31 May 1984 and informed him that Monolith 4 had been analyzed at the concrete/rock contact without any passive resistance wedge and was found to be stable. Also the deep seated sliding analysis along the shear zone (Elevation 989+) was stable.

(b) Mr. Gribar also stated that the analyses of the concrete/rock contacts for Monoliths 5 and 6 using no passive resistance wedge were stable.

(c) Upon returning to the Division office on Monday 4 June 1984, the undersigned discussed the shear zone with Mr. Gaddie and Mr. Ray (ORDED-T). Mr. Ray expressed concern that if a powerhouse was later constructed the foundation could possibly go below the shear zone causing Monolith 4 to become unstable. Since the contractor was preparing to place concrete in Monolith 9 and to avoid delays, it was decided to telephone Mr. Gribar for information on what criterion was used to analyzed the shear zone. Mr. Gribar was reached at the site the afternoon of 5 June and he reconfirmed that the sliding analysis of the shear zone proved stable using the passive wedge of siltstone above the plane. Mr. Gaddie informed Mr. Gribar of our concerns about the

stability of Monolith 4 if, in the future, a powerhouse became a reality. Mr. Gribar stated that it would be the proposing private sector's responsibility to take the necessary steps to assure the integrity of the dam. Mr. Gaddie and the undersigned concurred.

7. Conclusions:

(a) Based on the sliding stability analyses, the core borings and the rock wall behind Monoliths 5, 6, 7, 8 and 9, Monolith 4 will remain at the present founding grade (Elevation 995.6). Any future powerhouse construction will have to consider the shear zone.

(b) After reviewing the borings and the sliding analysis results given to Mr. Long by Mr. Gribar , Monoliths 5 & 6 will remain at the present founding elevation of 987.5.

(c) Borings in Phase II construction revealed several shear zones, stress relief joints and indurated clay beds. The above data needs to be compiled and studied before selecting the final grades.

8. Future Actions:

(a) Once the Pittsburgh District compiles the data, a meeting including structural and geotechnical members of ORPED, ORDED, OCE and ORHCD should be scheduled in August 1984 for the purpose of reviewing the foundation grades selected by the District. Reference paragraph 7(c).

(b) The resident office should continue to protect exposed rock walls and foundations. Detail foundation mapping and photography should be kept up to date.

9. The undersigned would like to express his appreciation to Pittsburgh/Huntington Districts and Project personnel for their efforts and cooperation in making this a very informative and productive site visit. Also, he commends the project personnel on the control blasting of the vertical rock walls.

Charles G. Canning

CHARLES G. CANNING
Division Geologist

CF: ORDCO
ORDED-T
ORPED-G
ORHCD-I
ORHCD-SWJ

US ARMY ENGINEER DISTRICT, PITTSBU
CORPS OF ENGINEERS
WILLIAM S. MOORHEAD FEDERAL BUILD
1000 LIBERTY AVENUE
PITTSBURGH, PENNSYLVANIA 15222

ORPED-G

12 June 1984

MEMORANDUM FOR RECORD

SUBJECT: Stonewall Jackson Dam Trip Report, Contract No. DACW59-C-83-0053

1. On 30 May 1984 Stuart Long, Chief of the Geology Section, and Marshall Fausold, Chief of the Geotechnical Branch, of the Pittsburgh District attended the Division Dam Safety Committee meeting at the Stonewall Jackson Dam site. The committee was given briefings on the geological and foundation conditions uncovered at the site and the instrumentation proposed for the dam. Following the meeting the group inspected the first stage construction.

2. On 31 May 1984 Charles Canning, Division Geologist, and Messrs. Long and Oshel (ORPED-I) inspected the foundation excavation of Monoliths 5 through 9 which were within inches of being at grade. The occurrence at the downstream vertical face of a soft clay shale/indurated clay seam approximately 1/2 to 1 foot above the final grade of Monoliths 5 and 6 was carefully investigated. It was decided to discuss the need for additional embedment with Mr. John Gribar, Chief, Structural Engineering Section, Design Branch. Specifically, he was asked if the design analysis had counted on any downstream passive resistance in order to meet the stability criteria. He responded that neither Monolith 5 nor 6 required a downstream "kicker" block and, therefore, the proximity of this soft seam would not pose any problems.

3. Mr. Canning had some concern over an apparent bedding plane at the vertical step between Monoliths 6 and 7. The line drilling at the step did not produce the neat line desired and gave a very irregular step. A special plug pour at the Monolith 6 - 7 joint will be required. It was decided to review the four-inch core at the site to determine if, in fact, there may have been a bedding plane at elevation 985. Borings 213, 212, and 211 were examined and it was confirmed that there is no bedding plane. The Resident Engineer was told that the foundation elevation for Monoliths 5 and 6 would not have to be changed.

4. There was also some concern expressed by Mr. Armstrong, Chief, Engineering Division, ORD, on the previous day about the unfavorable orientation of stress relief fractures in Monolith 4. Mr. Gribar was also asked if any downstream embedment was counted on for an adequate safety factor. Mr. Gribar confirmed that no passive resistance was required.

ORPED-[illegible] 12 June 19[illegible]

SUBJECT: Stonewall Jackson Dam Trip Report, Contract No. DACW 59-C-[illegible]

5. A review of the exploratory borings drilled to confirm founding elevations for Monoliths 10 thru 16 was conducted by Messrs. Canning, Long, Wabel, and Dave Hughes, Project Geologist. The following foundation elevations were agreed upon:

Monolith 10	Elev 967.0
Monolith 11	Elev 997.0
Monolith 14	Elev 1027.0
Monolith 15	Elev 1034.7
Monolith 16	Elev 1060.0

Founding elevations for Monoliths 12 and 13 were discussed, but no decision was reached until further analysis and detailed study of the area is made.

6. It is proposed to conduct these studies during the next two months and then to have a meeting with Pete Hart (OCE) and Charles Canning in August to agree on the foundation elevations of Monoliths 12 and 13.

STUART E. LONG
Chief, Geology Section

CF:

ORPED
ORPED-G
ORPED-D
ORHCD-I
ORHCD-Liaison
ATTN: Resident Engineer
Stonewall Jackson Lake Dam

ORHED-G

MEMORANDUM FOR RECORD

SUBJECT: Stonewall Jackson Trip Report, Contract No. DACW59-C-83-0053

1. Stuart Long and I accompanied Mr. David Hammer, ORDED-G, on an inspection trip of the Stonewall Jackson Project on 5-6 June 1984. We were escorted by Mr. Bill Woodburn, Resident Engineer.

2. The afternoon of 5 June was spent inspecting the various active relocation contracts of the project. U.S. Route 19, Phases I, II, and III and Equitable Access Roads Phase I were included. The Dam Access Road and associated Buttress Fill were inspected. In connection with the latter, we examined the area above the buttress where a landslide has developed. The area was rapidly drying compared to observations over the past several months. No recent movement has occurred.

3. Final foundation clean up and initial concrete placement in Monolith 9 was observed. Clean up was generally satisfactory, although a few areas required recleaning at our request. Dental concrete had already been placed in two areas in the left half of the monolith. Concrete placement began, with our concurrence, about 11:00 A.M. on 6 June. Final foundation clean up was not yet complete on the upstream 1/4 of the monolith foundation at that time. Although we concurred with initiating the concrete placement, we emphasized to Mr. Woodburn that foundation clean up should be complete prior to placement in all succeeding monoliths. Only one mixer at the batch plant was operating during this placement, the other having broken down on the initial charge. Concrete placement was proceeding slowly but generally satisfactorily as of our departure from the project at 2:00 P.M. Photographs taken during the inspection are attached.

4. Mr. Hammer expressed his satisfaction with the observations made during the inspection.

1 Incl
as

MARSHALL [illegible]
Chief, Geotechnical Branch

CF: (w/o incl)

ORDED-G
ATTN: Mr. Hammer

ORHCD-L
ATTN: Mr. Churna

ORHCD

(R-66)

ORPED-G 22 June 1984

MEMORANDUM FOR RECORD

SUBJECT: Stonewall Jackson Dam Trip Report, Contract No. DACW59-C-83-0053

1. Reference Memoranda on same subject dated 5 March through 11 June 1984.

2. Stuart Long, Chief of the Geology Section, and Robert John, Geologist, from the Pittsburgh District Geotechnical Branch visited the Stonewall Jackson Lake Dam site on 12 June 1984 to approve the foundation and observe the placement of concrete in Monolith 7.

3. By the time of our arrival on 12 June the foundation for Monolith 7 had been cleaned and was ready for final approval. After removal of some drummy rock and more extensive air-water jetting, Mr. Long approved the foundation. The final foundation surface is fairly irregular due to the undulating character of the sandstone and siltstone of which it is composed. Dave Nugen, project geologist, estimated that the average foundation elevation would be approximately 0.9 foot below the designed grade of 985.0. Boring 62 at the upstream end of the monolith had apparently been grouted prior to construction with poor quality grout and a small quantity of water was entering through this hole. NX Boring 43 was also encountered and required cleaning out to a depth of seven feet followed by backfilling with neat cement grout.

4. Concrete placement (3 inch max size aggregate) began at approximately 9:45 A.M. on 12 June at the downstream end of the monolith. Prior to the concrete, a thin layer of grout is placed over the foundation to provide a better bond between rock and concrete. Concrete is delivered to the site from the batch plant in two buckets of four cubic yards each carried on trucks. The time required to fill the two buckets was approximately five minutes at the time this procedure was observed. The contractor had three men operating the vibrators after each bucket is unloaded and each load is one foot to 1½ feet high after being leveled out. The overall appearance during the placement is one of terraces extending from the downstream end to the upstream end. As of 10:00 P.M. on 12 June it appeared that the first lift of this monolith was 75% complete. Placement had been continuous all day and would continue until completed.

5. A few problems were noted with the placement of concrete in Monolith 7. It was a sunny day with temperatures near 90° on the day of the visit, making it impossible to keep the foundation wet for any length of time. The part of the foundation that is a shaly siltstone tends to deteriorate fairly rapidly under wetting and drying conditions with the top layer

slaking off in small pieces. Theses areas required continuous cleaning during the day. It also appeared that there was a problem with segregation of the aggregate in some of the concrete. It is assumed that the problem does not lie in the proportioning procedure since the computerized batch plant virtually guarantees proper proportioning of concrete components. The contractor was made aware of the District's concerns in this matter. One possible solution mentioned was altering the way in which the concrete is dropped from the mixers into the discharge hopper. It was also noted that there were times when the concrete buckets were opened at too great a height above the previously placed concrete.

6. The first lift of concrete placed in Monolith 9 was observed. There is a lenticular void or small honey-combed zone at the upstream right corner of the monolith upstream of the water stop. It has some water flowing through it and should be treated soon. It appears that the foundation for Monolith 8 is going to be even more irregular than Monolith 9 when it is cleaned up. There is an especially large depression near the upstream end that may require a special plug pour.

7. Shotcreting of the indurated clay below the rock buttress on the left abutment has been completed and the results look good. There are a few areas where water is seeping out of holes in the shotcrete. This water is not doing any damage and it may even be a good idea to add a few more holes to facilitate drainage behind the shotcrete. The slides above the rock buttress appear to have stabilized with the onset of dry, warm weather.

8. Project personnel indicated that the next concrete placed would probably be the next lift of Monolith 9, although it is possible the work may move to the remaining left training wall monolith or Monolith 5 depending on the speed at which clean up progresses. Further site visits are planned as foundation preparation proceeds to concrete placement.

Robert Joh[illegible]
for STUART B. LONG
Chief, Geology Section

ORDED-G 5 September 1984

MEMORANDUM FOR THE RECORD

SUBJECT: Trip Report, Stonewall Jackson Dam
Inspection of Left Abutment Phase II Construction
Core Samples and Selection of Founding Grades

1. On 27 and 28 August 1984, the undersigned and Thurman Gaddie (ORDED-T) met with personnel from OCE, ORPED, ORHED and ORHCD-SWJ to inspect core samples and the left abutment.

2. Purpose: The purpose of the trip was to inspect the core samples taken from the left abutment by the contractor, visit the site and select the founding grades for monoliths 10 through 16. See Attachment 1 for agenda.

3. Attendees:

(a)	Pete Hart	Geologist	OCE
(b)	Bob Smith	Structural Engineer	OCE
(c)	John Gribar	Structural Engineer	ORPED-D
(d)	Joe Coletti	Chief, Design Branch	ORPED-D
(e)	Marshall Fausold	Chief, Geotech. Section	ORPED-G
(f)	Stu Long	Geologist	ORPED-G
(g)	Bob John	Geologist	ORPED-G
(h)	Thurman Gaddie	Structural Engineer	ORDED-T
(i)	Charlie Canning	Geologist	ORDED-G
(j)	Joe Turner	Chief, Inspection Br.	ORHCD-I
(k)	Pat Oshel	Geologist	ORHCD-I
(l)	Bill Woodburn	Resident Engineer	ORHCD-SWJ
(m)	Dave Nugen	Project Geologist	ORHCD-SWJ
(n)	Red Hamric	Chief of Inspection	ORHCD-SWJ

4. Background: During the meeting of 30 May thru 1 June 1984, the writer and Stu Long (ORPED-G) inspected the Phase II contract boring samples for the left abutment. Some of these additional borings confirmed the grades selected during design. However, borings in monoliths 12, 13 and possibly 16 indicated the design grades in these monoliths required a more indepth review of the geology. The writer recommended to Pittsburgh District that they should compile the additional data and schedule a meeting with structural and geotechnical members of OCE, ORDED, ORPED, ORHCD and ORHCD-SWJ for a review of final grade selection.

5. Observations:

(a) OCE and ORDED members were met at the airport by Stu Long and Bob John (ORPED). The group proceeded to the core storage warehouse on Neville Island for a review of the compiled geotechnical data and core inspection. Stu Long and Bob John briefed the group on the results of additional boring data and their recommendation for final founding grades. They had prepared a number of geological sections at various orientations

to the dam axis depicting several problem areas in monoliths 12, 13 and 16. The remainder of the day was spent inspecting the core samples and discussing the founding grades. At 1600 hours the group departed for Stonewall Jackson.

(b) The morning of 28 August, Mr. Long briefed the ORH and ORP members not present at the core inspecting, on the previous day meeting. He then presented the following founding grades that had been agreed to during the core inspection on 27 August.

Monolith No.	Design Grade	Final Grade
10	985	985
11	987	985
14	1027	1027
15	1040	1040

The remaining monolith grades(12, 13 and 16) were presented with several geological discrepancies that had caused some doubt as to the original design grades being pointed out.

The following grades were open for discussion:

Monolith No.	Design Grade	Final Grade
12	990	990
13	1018	1000
16	1058	1060

There is some question as to Monolith 12 remaining at Elev. 990 as Boring 207 encountered a sheared and crushed zone and soft claystone from elevation 986 to 980 (for boring locations see Attachment 2). To determine the attitude and extent of this zone, Boring 218 was drilled approximately 20 feet downstream of Boring 207. Boring 218 encountered only a small zone of claystone with occasional slickensided surfaces at Elev. 981.9 to 980.7. (See Photo Nos. 20, 21 & 22.) Boring 108 did reveal a soft clayshale at Elev. 981.3 to 979.7 that contained some slicks. However, Borings 208 and 219 did not encounter any soft zones at these elevations. (See Photo Nos. 14 & 15). Bob Smith (OCE) asked John Gribar (ORPED) about the stability of this monolith. John Gribar stated that considering the depth of burial the sliding factors of safety range between 5 and 7, and bearing loads were well within the bearing capacity of the rock. Bob Smith stated that since stability was not an issue his main concern was the possibility of excessive seepage within the shear zone.

The group discussed lowering monolith 13 from Elev. 1018 to 1000. Stu Long (ORPED) went over the borings and geological sections indicating some soft material (claystone and coal) would be in the vertical rock face between monolith 12 and 13. See photographs 10 through 20. Marshall Fausold (ORPED) asked if the reason for lowering the foundation was stability. John Gribar stated that the sliding factor of safety was high when taking the depth of burial into consideration. Bob Smith (OCE) stated that

it appeared that either founding elevation would be satisfactory as far as stability was concerned. The writer stated that his main concern was maintaining a 28 foot vertical wall in the weak coal and surrounding soft sheared claystone. He recommended that the monolith be lowered to Elev. 1000 thus moving the face farther back into the abutment. Core borings indicate that as you move back into the abutment the rock becomes sounder. See photographs 1 through 3, 7 through 20 and Attachment 2 for boring locations.

The group next discussed monolith 16. Thurman Gaddie stated his concern that we would not be able to maintain the vertical wall between monoliths 15 & 16 due to the deterioration of several clay beds exposed for most of the construction period. See photographs 4, 5 and 6.

(c) Following the briefing and discussion, the group visited the site to inspect existing rock faces excavated during Phase I construction. Exposures of similar material located in the right abutment and in the left bank of the diversion channel gave some indication as to the type rock structure and its physical characteristics expected to be encountered in Phase II excavations. See photographs 23, 24 and 25.

6. <u>Discussions:</u>

(a) After lunch the group discussed what had been seen in the field. Stu Long (ORPED-G) briefly stated the conclusions reached during the morning meeting on the founding grades for monoliths 10, 11, 14, and 15. The grades for monoliths 12, 13 and 16 were still open for discussion.

Bob Smith (OCE) stated that since the problems with monoliths 12, 13 and 16 were not structural but related to construction excavation of the vertical faces, design grades or proposed final grades would be suitable. Pete Hart stated that the design grades should remain as the final grades. He proposed that during excavation the faces could be inspected and if necessary moved back into the abutment. Bill Woodburn, Pat Oshel, David Nugen and Joe Turner of Huntington were in disagreement with this approach as it could be interpreted as a changed condition. Bill Woodburn informed the group that he favored lowering the grade for monolith 13 to Elev. 1000, which would move the 27 foot vertical face farther back into the abutment. The cost of the additional excavation and concrete would be approximately $150,000 to $160,000 compared to a possible costly change condition claim with all its ripple effects. The writer stated that after reviewing the borings and site visit all indications were that the rock would improve as you go back into the abutment. Therefore, the foundation should be lowered to Elev. 1000. This would also assure tighter rock faces at monolith joints 12, 13 & 14 to aid in reducing possible seepage. See photographs 10 through 20 for rock material between Elev. 1018, 1000 and 990.

Marshall Fausold and Joe Coletti (ORPED) recommended additional drilling before selecting the final grades.

(b) Monoliths 12 and 16 founding grades were discussed by the group. The shear zone in the left downstream corner of monolith 12 is more of a seepage problem than structural. The vertical face between monoliths 15 and 16 may give trouble due to the indurated clay layer. However, based on the condition of the indurated clay beds encountered in monolith 1, the founding grade for the monolith would remain as proposed by the Pittsburgh District. See photographs 24 and 25.

7. <u>Conclusions:</u> The group mutually agreed on the following:

(a) Monoliths 10, 11, 14 and 15 will be founded at the proposed elevations of 985, 985, 1027 and 1040, respectively.

(b) Based on the core recovery, the condition of the indurated clay beds exposed in the right abutment and the small size of the structure, monolith 16 will be founded at Elev. 1060 as proposed by Pittsburgh.

(c) The final grades for monoliths 12 & 13 will be selected after additional drilling. For location of additional borings, see Attachment 2.

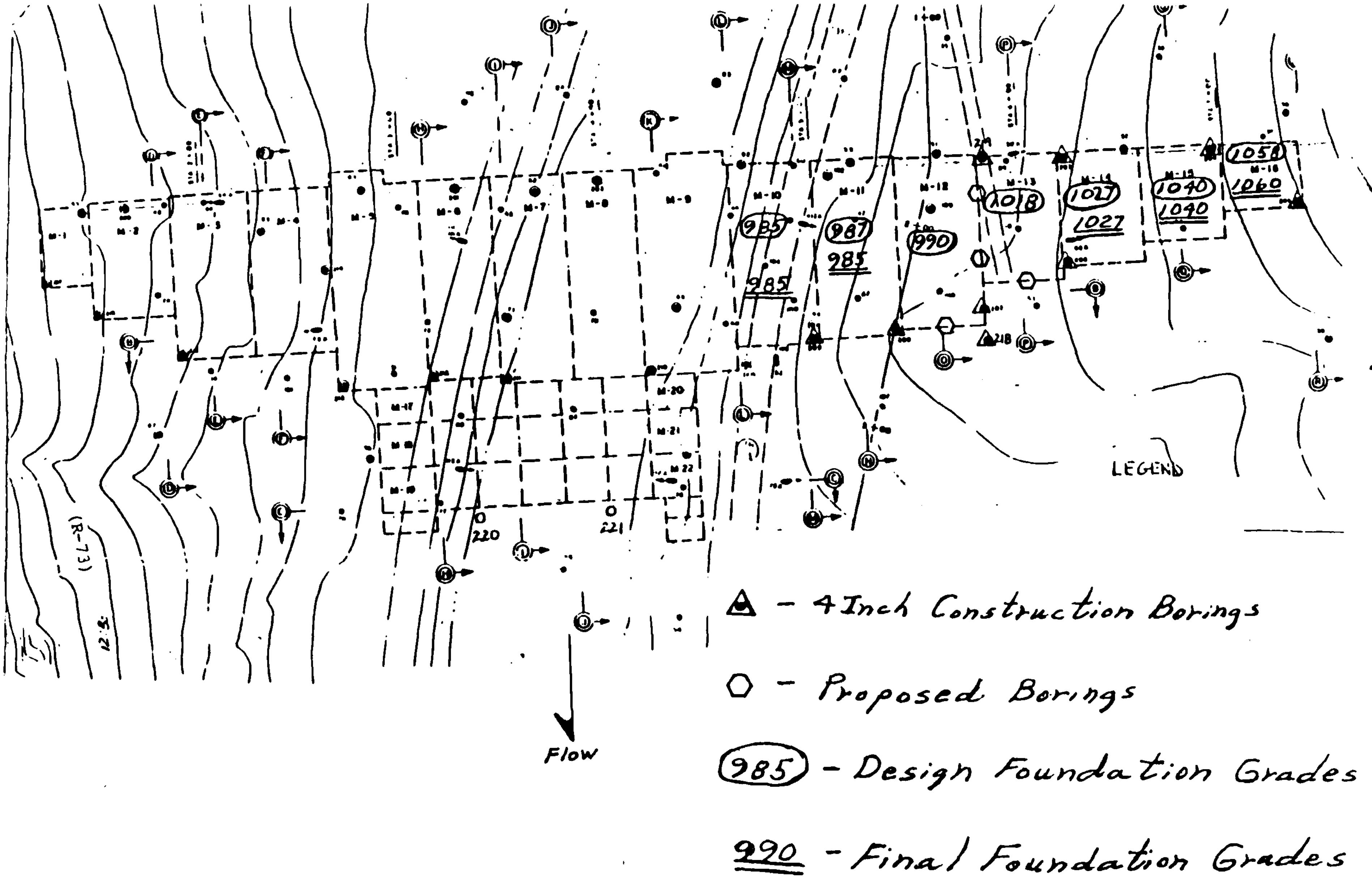
8. <u>Future Actions:</u> The Pittsburgh District will arrange to drill borings in and around monolith 12 and along the monolith joint line between monoliths 12 and 13. Borings encountering the shear zone will be pressure tested. Upon completion of the investigation, Pittsburgh District will contact Division and arrange a meeting with personnel from OCE, ORDED-G, ORHCD-I and ORHCD-SWJ. Final grades for the above monoliths will be selected at that time.

The writer wishes to express his appreciation to Stu Long and Bob John for a well prepared and informative briefing. Also his thanks to the Huntington District for their assistance and cooperation.

Charles G. Canning

CHARLES G. CANNING
Division Geologist
ORDED-G

CF:
ORDED-T
ORDCO
ORPED-G
ORPED-D
ORHCD-I
ORHCD-SWJ



Attachment No. 2

ORPED-G 12 September 1984

MEMORANDUM FOR RECORD

SUBJECT: Stonewall Jackson Dam Trip Report, Contract No. DACW59-83-C-0053

1. Reference: Memoranda on same subject, dated 5 March through 22 June 84.

2. A geotechnical and structural review of foundation elevations for Monoliths 10 through 16 on the left abutment at Stonewall Jackson Dam was held 27 and 28 August 1984. Tentative elevations had previously been selected regarding these foundations. This meeting was set up to confirm the elevations selected through discussions between structural and geotechnical representatives from the Office of the Chief of Engineers, the Ohio River Division, and the Pittsburgh and Huntington Districts.

3. Representing OCE in the geotechnical and structural disciplines were Mr. Pete Hart and Mr. Bob Smith, respectively. Mr. Charlie Canning and Mr. Thurman Gaddie represented ORD in the same areas. They were met at the airport by Messrs. Stuart Long, Chief of the Geology Section, and Bob John of the Pittsburgh District Geotechnical Branch, and traveled to Neville Island (PEWARS) for a briefing on the background of the Stonewall Jackson project and progress there to date. Following the briefing, the group viewed the core borings from the left abutment which had been laid out at the warehouse, concentrating on the 200-series borings drilled in February and March of 1984 as part of the dam contract. While viewing the core, the group also analyzed geologic cross sections of the abutment prepared by the Pittsburgh District and three-dimensional sections prepared by Mr. Canning. Following the review of the core borings, the group traveled to the project.

4. Joining this group at the dam site for a site visit and meetings on 28 August were the following:

Pat Oshel	ORHCD-I
Bill Woodburn	ORHCD-SSJ, Stonewall Jackson Resident Engineer
Dan Nugen	ORHCD-SSJ, Project Geologist
Red Hamric	ORHCD-SSJ, Field Engineer
Joe Turner	ORHCD-I
Marshall Fausold	ORPED-G, Chief, Geotechnical Branch
John Gribar	ORPED-DM, Chief, Structural Section
Joe Coletti	ORPED-D, Chief, Design Branch

Mr. Long opened the meeting with a summary of the previous day's review of the core borings and sections. The left abutment is characterized by gouge and shear zones of varying thickness and continuity, unlike the right abutment which was relatively free of such weak areas. In general, the shears

are oriented such that they dip down into the abutment and also dip down slightly in the upstream direction. The left side of the diversion channel excavation above the shotcrete provides a good example of the type of shear and weak seams that appear to extend under the abutment. They are a proble primarily in only the Monolith 12 and 13 foundation areas; due to their orientation they will be excavated in Monolith 10 and 11 and be far below foundation grade in Monoliths 14 through 16. Mr. Long proposed the following foundation elevations:

Monolith 10	985
Monolith 11	985
Monolith 12	990
Monolith 13	1000
Monolith 14	1027
Monolith 15	1040
Monolith 16	1060

The proposal to lower Monolith 13 from 1018 to 1000 was the major change from the original plans and specifications and became the main topic of discussion for the rest of the meeting. The sections and borings show that there are frequent clay gouges, shears, and areas of core loss in the Monolith 12 and 13 area from elevation 1015 down to 1000. The Redstone coal is also located in this zone. Those in favor of lowering the foundation feel that if there is any doubt as to the competency of the rock, it should be taken out, adding that it would probably be cheaper to do this now than to have the foundation shot to 1018 and then decide to lower it. Others in the group questioned the need to lower the foundation at all. Their major contention is that even at 1018 there is a minimum of 20 feet of embedment into rock for this monolith, and the computed factor of safety is a minimum of 7.46 (for Case IV - Flood Discharge Condition). Sliding stability at a weak seam under Monolith 12 was analyzed and showed a factor of safety greater than 10; however, Monolith 13 was not analyzed in this way. After further discussion, it was generally agreed that neither sliding stability nor settlement warrant further concern. Underseepage through the fractured zones was noted as a potential problem in that a high inflow to the gallery through foundation drains could require excessive pumping. The principal concern, however, focused on the risk of losing the excavated face between Monoliths 12 and 13 if the founding elevation of 13 is not lowered to 1000.

5. As far as underseepage is concerned, should the Monolith 13 founding elevation be kept at 1018, a few possible measures to alleviate any potential problem were discussed. Among these were an angled grout curtain upstream of the monolith face and additional drains constructed through the dam. Such grouting would have limited effectiveness in gouge zones but it would provide additional seepage cutoff in the case of vertical fractures or open planes. Where the clay filling of the gouge zones limits grout effectiveness, it should likewise inhibit high flow.

6. There was much discussion about maintaining the vertical step between either Monolith 12/13 or 13/14, depending on which founding elevation is selected for Monolith 13. The vertical face in question would be either 28 feet high between 12/13 (if 13 is kept at 1018) or 27 feet high between 13/14 (if 13 is lowered to 1000). The point was brought out, particularly by Mr. Canning, that near-surface rock tends to become more competent further back into the abutment, thus increasing the chance of successfully maintaining the face. It was agreed that the contractor had done a very good job of excavating and maintaining vertical faces in some poor quality rock during Stage 1 excavation. The final result of the meeting as far as Monoliths 12 and 13 founding elevations are concerned was a decision to drill four more borings in this area, one each at the downstream ends of Monoliths 12 and 13 and two on what will be the joint between Monoliths 12 and 13. These will be drilled to confirm 990 as the founding elevation for Monolith 12 and to better determine the quality of the questionable rock between elevations 1018 and 1000. Crown Pressure Grouting, the firm that did the additional drilling under the dam contract, will be contacted about returning to the site to drill the four additional holes. In addition, the Huntington and Louisville Districts and the Waterways Experiment Station will be asked about the availability of their drill crews.

7. Mr. Hart requested that OCE and ORD be advised when the drilling is completed in order that they may review the borings and logs with the Districts. They will evaluate the quality of the rock and determine whether it appears more competent than that represented by the core examined at Neville Island on 27 August. If such distinct improvement is confirmed, a founding elevation for Monolith 13 of 1018 will be confirmed; otherwise it will be lowered to 1000.

8. The foundation elevations proposed by Mr. Long for Monoliths 10, 11, 14, 15, and 16 were approved. There was some concern about founding Monolith 16 above an indurated clay/claystone unit, but the borings indicate that the siltstone cap on which 16 will be founded, and which overlies the claystone, is continuous over the foundation. It is four to six feet in thickness and the claystone itself appears to be competent. In addition, Mr. Gribar pointed out that at the founding elevation of 1060 there is already 25 feet of embedment for a monolith 42 feet high and the factor of safety for Monolith 16 as designed was high. Founding Monolith 16 at 1060 was approved contingent on treating the vertical face between Monolith 15 and 16 to protect it until concrete is placed. Celtite Epoxy Resin will probably be used rather than shotcrete.

STUART B. LONG
Chief, Geology Section

ORPED-G 14 September 1984

MEMORANDUM FOR RECORD

SUBJECT: Stonewall Jackson Dam Trip Report, Contract No. DACW59-83-C-0053

1. Reference Memoranda on same subject, dated 5 March through 12 September 1984.

2. Inspections of the foundations for Monoliths 4 and 2 were conducted by personnel from the Pittsburgh District Geotechnical Branch on 15/16 August and 5/6 September 1984, respectively. Monolith 4 was inspected by Charles Stevenson, Civil Engineer, and Robert John, Geologist, and Monolith 2 was inspected by the latter and Stuart Long, Chief of the Geology Section.

3. The foundation for Monolith 4 was closely inspected for excessive breakage of the foundation rock caused by the fact that the haul road passed over it prior to the final excavation. However, the inspection did not show any apparent rebounding phenomena or excessive breakage at foundation grade. There were naturally occurring joints and fractures in the foundation, oriented primarily east-west (diagonally across the foundation) and upstream-downstream. A small quantity of water was entering the excavation from a horizontal fracture in the foundation located near the downstream end of the monolith to the left of the center line. The final foundation was generally a sandy siltstone with occasional hard, black, siliceous nodules. After the loose material in the fractured zones was removed and the surface cleaned with water jets, the foundation was approved for concrete placement.

4. The approval (subject to resolution of District comments) of the Contractor's VE proposal to utilize Monolith 4 for diversion during the second stage of construction resulted in the first lift of this monolith covering a larger area than originally designed. (See attached photo and map.) In order to prevent possible undercutting from water cascading over Monolith 4, concrete was placed on the roughly triangular area indicated at the downstream end of Monolith 4. The formwork for this area can be seen in the picture extending downstream from the edge of Monolith 5. Foundation clean-up for this section was not as extensive as that for the rest of the monolith but the foundation was taken down below the coal into the underlying claystone and siltstone. Subsequent lifts will revert back to the originally designed dimensions.

5. Final foundation preparation for Monolith 2 was more complicated than that for Monolith 4. As mentioned in the memorandum of 11 May 1984, the left side of this foundation is characterized by subparallel weathered

fractures and a fault plane. This results in a very irregular foundation once the broken and rust-stained material associated with these zones is removed. The fault trace could be followed on all three side walls as well as the foundation and there was a small amount of water entering the excavation through it on the landward side. Mr. Long requested that the workmen cleaning the foundation be especially diligent in removing the clay gouge and rock fragments associated with these fractured zones and suggested using air and water jets with more power than the ones they started with. It was important that these zones be cleaned out properly since some of them extend the whole length of the monolith and could form a continuous upstream/downstream seepage path. Also prior to concrete placement, two six-inch borings and an angled NX boring at the upstream end of the monolith had to be regrouted.

6. The initial placement of concrete in Monolith 2 was observed following approval of the foundation. As usual, a thin layer of grout was placed over the part of the foundation where concrete was to be placed. The deep crevices left in the foundation after removal of loose and broken rock in the fracture zones were filled with 3/4 inch top size aggregate concrete and vibrated to work the grout down into the crack. Mr. Woodburn, Resident Engineer at the project, indicated that the entire first lift on Monolith 2 would have 1-1/2 inch maximum size aggregate rather than the usual three inch size.

7. Aside from the training walls and stilling basin monoliths, Monolith 1 is the only foundation in the Stage 1 construction lacking a final approval of the foundation. A preliminary inspection was done in mid-April when it was first shot to grade. Concrete placement in this monolith is scheduled for later this fall, at which time the foundation will be reinspected. Rust-stained joints and fractures similar to those encountered in the Monolith 2 foundation are expected.

1 Incl
as

ROBERT JOHN

CF:
ORPED
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ORHCD - Liaison
ATTN: Resident Engineer
Stonewall Jackson Lake Dam

ORPED-G

6 November 1984

MEMORANDUM FOR RECORD

SUBJECT: Stonewall Jackson Dam Trip Report, Contract No. DACW59-83-C-0053

1. Reference: Memoranda on same subject dated 5 March through 14 September 1984.

2. Stuart Long, Chief of the Geology Section, and Robert John, Geologist, of the Pittsburgh District Geotechnical Branch visited the Stonewall Jackson Dam project on 16 and 17 October 1984, for the purposes of inspecting the foundation of Monolith 1 prior to concrete placement and logging the rock core from borings 222 through 226. These five borings were drilled as a result of the geotechnical and structural review of left abutment monoliths held on 27 and 28 August 1984 (Reference 12 September 1984 memo). Their locations are shown on the attached map.

3. The foundation for Monolith 1 was a bluish gray silty sandstone. Four major joints and associated smaller joints were revealed in the riverward half of the foundation. These joints ran upstream/downstream, trending roughly N 40° E. They were rust stained and filled with broken rock fragments, similar to those found in the Monolith 2 foundation although the zone of weathering did not seem as wide or as deep as that associated with the Monolith 2 joints. The joints in the floor of Monolith 1 ranged from two inches to eight inches in width at the surface and appeared to be nearly vertical. Material in the joints was loosened with a jackhammer, after which the joints were cleaned out using air and water jets under high pressure. This system proved to be very effective at removing loose material. The side walls of the excavation were also hosed down. Grout was broomed into the fractures prior to concrete placement but in general, the foundation was not nearly as irregular as that in Monolith 2 and dental concrete was not necessary.

4. The decision had been made at the geotechnical review meeting on 27 and 28 August to drill more borings in the vicinity of Monoliths 12 and 13 before determining final foundation elevations for these monoliths. The foundation for Monolith 12 has tentatively been set at elevation 990 but shears and broken zones found in boring 222 between 990 and 987 indicate that at least the downstream end may have to be lowered somewhat. Borings 223, 224, and 225 all show frequent shears and broken zones between elevations 1020 and 1005. Boring 226, located on what will be the joint

between Monoliths 13 and 14, indicates that the rock is apparently becoming more competent as distance into the abutment increases. It appears that maintaining the 27-foot vertical face between Monoliths 13 and 14 (if Monolith 13 is lowered to 1000) would not present any major problems other than some rock bolting and the application of a protective coating.

5. A more detailed study of this area incorporating the new borings into existing geologic sections will be done soon, after which another geotechnical review with representatives from OCE and ORD will be held. At that time, a final decision on the Monolith 12 and 13 foundations will be made.

6. The only foundations within the first stage cofferdam that are lacking initial concrete placement are in the stilling basin and right training wall. Additional trips to the project are planned as work in these areas progresses.

STUART B. LONG
Chief, Geology Section

CF:

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ORHCD - Liaison
ATTN: Resident Engr
Stonewall Jackson Lake Dam

ORPED-G 5 December 1984

MEMORANDUM FOR RECORD

SUBJECT: Stonewall Jackson Dam Trip Report Contract No. DACW59-83-C-0053

1. Reference memoranda on same subject dated 5 March through 6 November 1984.

2. The geotechnical and structural review of foundation elevations for left abutment monoliths at the Stonewall Jackson Dam project, held on 27 and 28 August 1984, left unresolved the final founding elevation for Monolith 13, pending the results of the drilling of additional core borings in this area. The foundation of Monolith 13, as designed, is 1018, but the presence of frequent shears and weak zones between elevations 1015 and 1000 in the left abutment had led to a proposal to lower the founding elevation to 1000. As noted in the 12 September memo, the principal concerns were underseepage from the reservoir through this fractured and sheared zone and the problems associated with trying to maintain a vertical cut face between Monoliths 12 and 13 in this type of material. It was agreed at that time that sliding stability would not be a problem regardless of which founding elevation was selected, because the monolith is deeply embedded in rock even at 1018.

3. The five additional borings were completed by 9 October 1984 (see attached location map for their locations). After review of the core borings by Stuart Long and Bob John of the Pittsburgh District, Geotechnical Branch, the boxes were shipped to the Neville Island warehouse and another geotechnical and structural review meeting was set up for 27 and 28 November 1984. The first part of this review was held at Neville Island (PEWARS) with the following people in attendance:

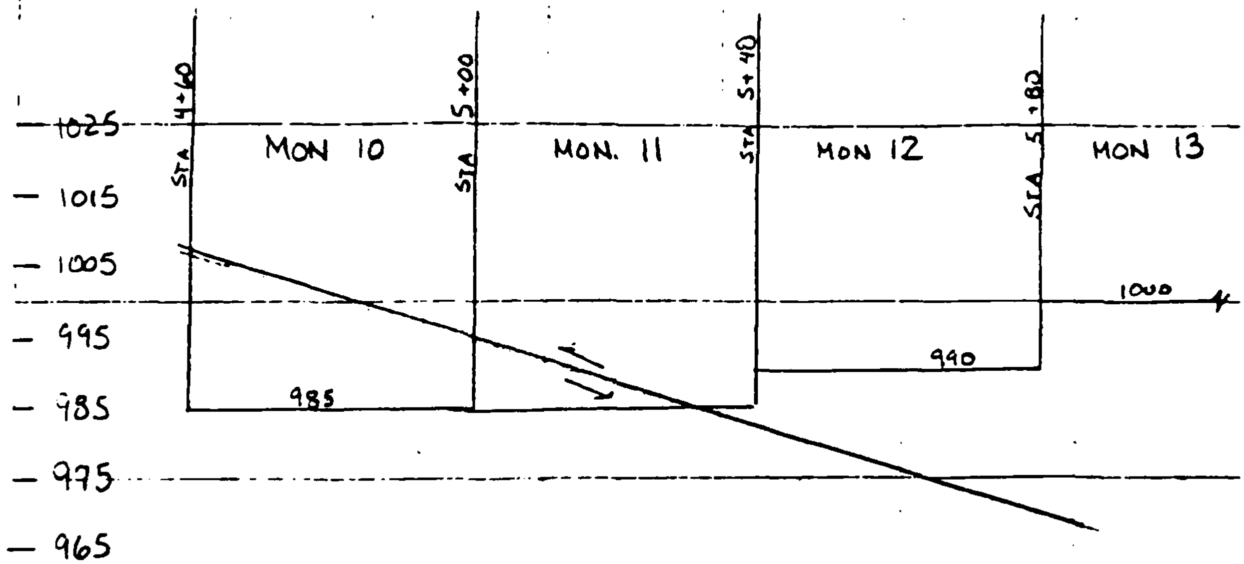
Peter Hart	OCE, Geologist
David Hammer	ORD, Chief, Geotechnical Branch
Joe Coletti	ORPED-D, Chief, Design Branch
John Gribar	ORPED-DM, Chief, Structural Section
Marshall Fausold	ORPED-G, Chief, Geotechnical Branch
Stuart Long	ORPED-GG, Chief, Geology Section
Pat Oshel	ORHCD-I, Geologist
Bob John	ORPED-GG, Geologist

4. The meeting opened with discussions on the results of the previous review in August and remarks on the latest drilling program by the ORPED-G representatives. The group then had the opportunity to examine geologic

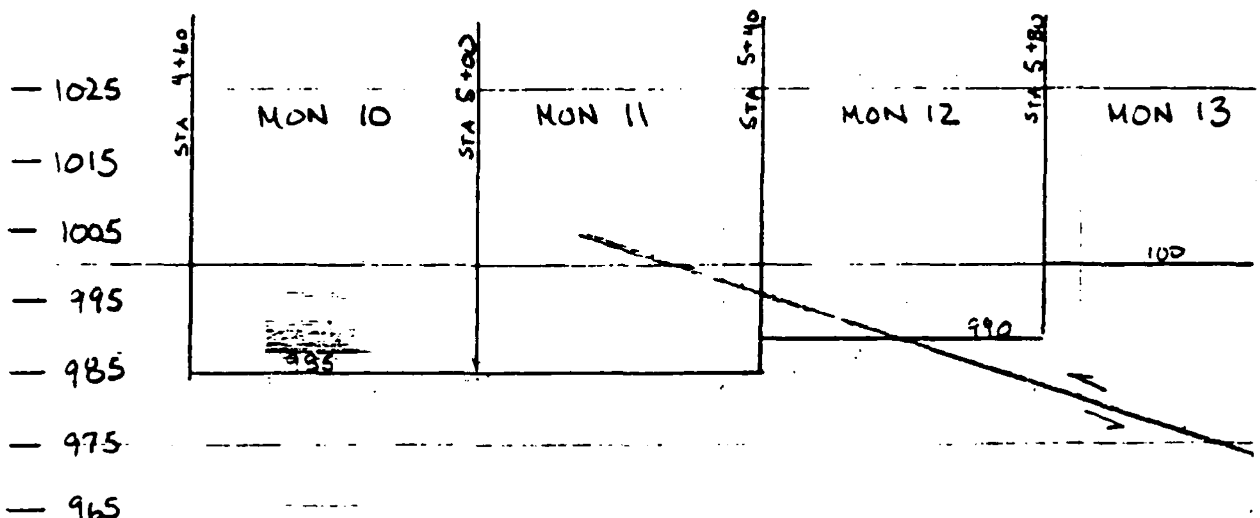
sections both parallel and perpendicular to the axis of the dam in the area of Monoliths 10 to 14, prepared by ORPED-G, including a three dimensional representation. Correlation of the borings indicates that the zone containing sheared and otherwise disturbed rock is continuous through the abutment ranging in elevation from approximately 1002 to 1016. This zone also contains the Redstone Coal. The additional borings confirmed the existence of this fairly continuous zone of weak and fractured material which would be below design foundation grade in Monolith 13. The group then examined the core from these new borings 222-226 as well as from the older borings still laid out from the first phase of the construction drilling (especially 203, 206, 207, 218, and 219).

5. Mr. Long, with Mr. Oshel's concurrence, proposed that the foundation of Monolith 13 be lowered from its design elevation of 1018 to 1000. While the stability of the monolith is not really an issue due to its deep embedment, he noted that he still would not be comfortable founding a monolith above a zone with so much sheared and fractured material. He felt that attempting to grout this zone would not be effective, especially when considering the difficulty of washing out all the thin clay seams present. Mr. Gribar noted that to lower the foundation would cost an additional $159,000 approximately. The concern over piping through the weak zone was mentioned, as well as potential settlement should piping become severe. Mr. Fausold offered the possibility of leaving the foundation at 1018 and then doing remedial grouting if a seepage problem does develop. Mr. Hart responded that it has been his experience that such rehabilitation grouting is often ineffective and it may be better to remove the questionable material now than have to rely on remedial work. Mr. Coletti raised the question of the stability of the vertical steps between monoliths. Examination of boring 226 on the Monolith 13/14 joint indicates there is a good, hard sandstone cap overlying the occasionally sheared and fractured zone from elevation 1015.5 to 1003.6, which would offer protection at the top of the step. Messrs. Long and Oshel pointed out that the 27-foot step between Monoliths 13 and 14 (if 13 is lowered to 1000) would be line drilled and treated with a protective coating and rock bolts as conditions warrant them. It was also mentioned that borings indicate the material is more competent at the 13/14 joint than at the 12/13 joint which would be a step of similar height if the foundation is not lowered. Mr. Hammer summarized the situation by stating that there seemed to be enough concerns of various natures about the sheared zone that it would be in the best interest of the project to lower the Monolith 13 foundation from 1018 to 1000. He compared this to having insurance against potential problems that could be caused by underseepage or stability of the faces during construction. A general consensus was reached by the group that the foundation of Monolith 13 should be lowered to 1000.

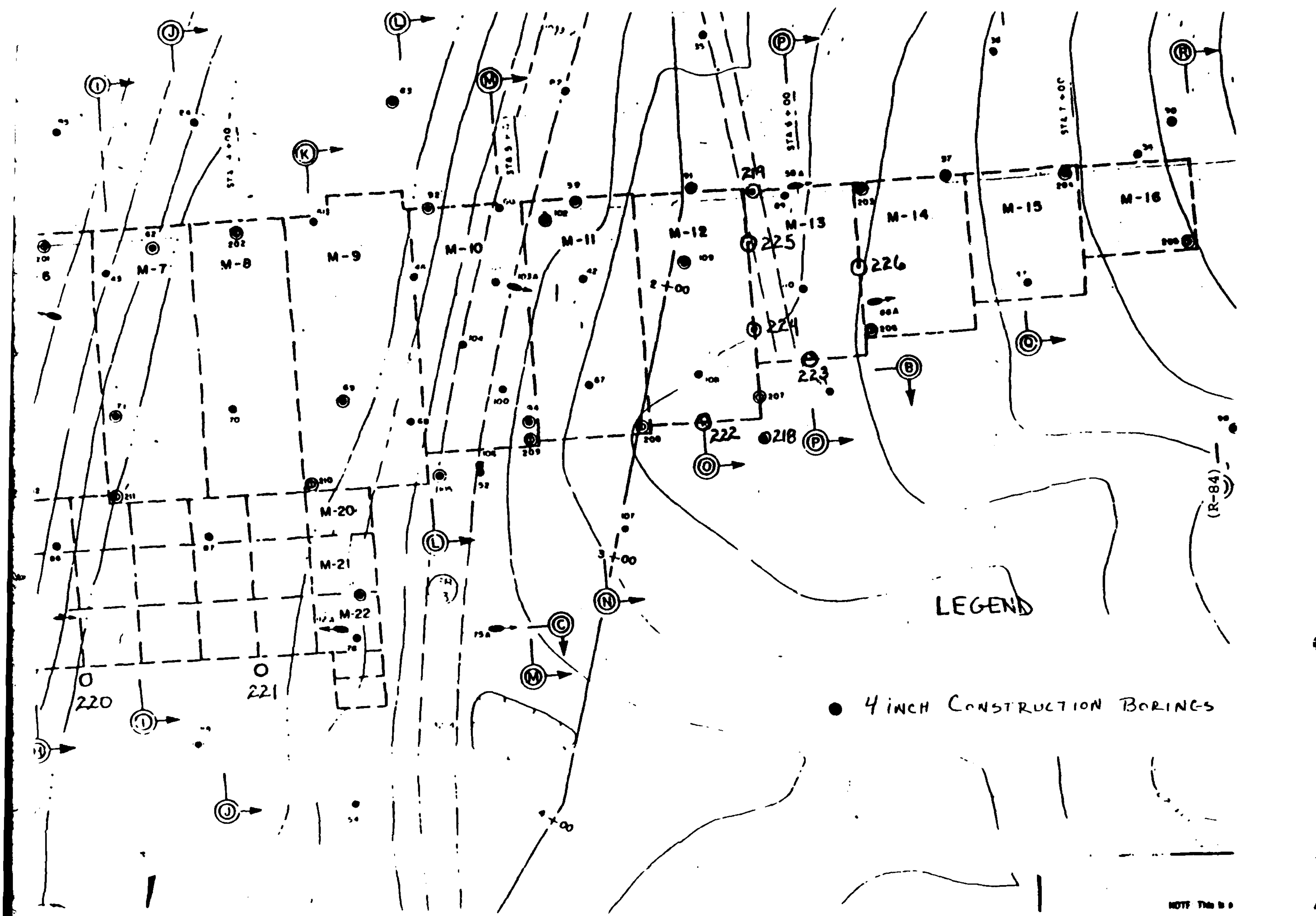
CORPS OF ENGINEERS, U.S. ARMY OHIO RIVER DIVISION	COMPUTATION SHEET	DATE 29 NOV 84
INSTALLATION	SUBJECT STONEWALL JACKSON LAKE DAM	
COMPUTED BY RLJ	COMPUTATION ORIENTATION OF POSSIBLE FAULT IN LEFT ABUTMENT	NUMBER
CHECKED BY		



ORIENTATION OF POSSIBLE FAULT
AT UPSTREAM END OF DAM



ORIENTATION OF POSSIBLE FAULT
ON AXIS 65' DOWNSTREAM OF
THE AXIS OF THE DAM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(R-84)
LEGEND
4 inch Construction Borings

ORPED-G 25 March 1985

MEMORANDUM FOR RECORD

SUBJECT: Stonewall Jackson Dam Trip Report, Contract No. DACW59-83-C-0053

1. Reference: Memoranda on same subject dated 5 March through 5 December 1984.

2. Stuart Long, Chief of the Geology Section of the Pittsburgh District Geotechnical Branch, visited the Stonewall Jackson Dam project on 13 and 14 March 1985 for the purposes of inspecting rock excavation, vibration monitoring, and general status of construction of the dam.

3. Foundation Preparation - The foundations for left abutment Monoliths 16 and 15 had been excavated to design grade, elevation 1060 and 1040 respectively, and covered with sand. Monolith 14 was excavated to design grade elevation 1027 but was not yet cleaned off. Line drilling along the Monolith 14-13 step was completed and loading of the pre-split line downstream of Monolith 13 was underway.

4. Cut Slopes and Excavation in Rock. The drilling and blasting on the left abutment continue to produce rock slopes cut and dressed to specifications and precise steps between monoliths. Since these abutment monolith foundations will be exposed for a relatively long period of time, Celtite protective coating will be applied to the vertical faces between monoliths.

5. Chain Link Fabric - At this time there is no protective mesh placed over the side wall cuts of the left abutment monoliths. With the construction of a rock fill haul road above Monolith 16 there is the possibility of rock rolling into Monolith 16. For this reason it was agreed to place chain link fabric not only on the landward cut of Monolith 16 but to carry it up the slope to the top of the haul road fill. This should provide additional personnel protection.

6. Rock Reinforcement - The reinforced rock block section between Monolith 9 and the Stage I diversion channel is being drilled and shot. One blast at approximate Station 2+00 (diversion channel) was witnessed by the undersigned. Examination after the detonation revealed very little fly rock and reasonably good fragmentation. The Dywidag rock bolts did not seem to present problems to the rock excavation. However, since the excavation was being limited to the top 10-12 feet of the rock block, more difficulty may be encountered when the resin portion of the rock bolt is reached.

7. Blast Vibration Monitoring - After the above blast, I inspected the seismograph and the resulting data sheet. The instrument, a Vibra Tape Particle Velocity Analog Recorder, Model 1090, was located on the floor of the operations gallery of Monolith 9 at elevation 1028. Monolith 9 is currently constructed to elevation 1040. The attached data sheet for this blast No. 11 indicated a peak particle velocity (PPV) of 0.04 inch per second (IPS), well below the maximum allowable PPV of 2 inches per second. The project geologist, Dave Nugen, was asked to verify the indicated reading and to furnish the Geotech Branch with a copy of this data sheet. A review of the record data submitted to the Resident Engineer's Office indicated that the maximum recorded blast produced 1 IPS. (See enclosed seismographic report for blast No. 5.)

8. Concrete Placement - No concrete is scheduled to be placed until April. Forms were being placed in Monolith 7.

9. Stage II Diversion. The gage reading downstream read 1017.6 and falling on 13 March. The stone protection and H-beam retaining wall were performing well under these higher flows.

10. Left Abutment Slide Area and Rock Buttress - The slide continued to make gradual movements in the area of the left abutment (see MFR dtd, 19 Apr 1984). Spring rains have thoroughly saturated the slide mass and only one new fissure has opened near Monument No. 2. It was requested that a survey of the instrumentation bench marks be made on the left abutment rock buttress. Geotech plans to develop a drainage system for the slide area in the near future.

11. Future Inspections - Due to the concern of special treatment of the Monolith 13/14 joint and the Monolith 13 foundation, the next field inspection is scheduled when Monolith 13 excavation is cleaned off to elevation 1005, five feet above design grade, project personnel will notify Geotech.

Encls

STUART B. LONG
Chief, Geology Section

CF:

ORPED
ORPED-G
ORPED-D
ORHCD-I
Resident Engineer, Stonewall Jackson Lake
ATTN: ORHCD-Liaison

ORPED-G 17 April 1985

MEMORANDUM FOR RECORD

SUBJECT: Stonewall Jackson Dam Trip Report, Contract No. DACW59-83-C-0053

1. Reference memoranda on same subject dated 5 March 1984 through 25 March 1985.

2. The Stonewall Jackson Lake Dam project was visited on 8 April 1985 to inspect rock excavation and foundation conditions in the left abutment. At the time of the visit, all anticipated rock blasting had been completed and Monoliths 10 through 16 were shot to their design grades. Monoliths 14 through 16 have undergone a preliminary cleanup and are covered with sand and plastic for protection. Monolith 13 was still partially covered with debris. A backhoe was working in the Monolith 10 through 12 area, removing remaining loose material.

3. As expected, evidence of faulting has been exposed by the excavation for Monoliths 11 and 12 (reference paragraph 6 of the 5 December 1984 MFR). Monolith 11 is currently at design elevation 985 while Monolith 12 was shot to 990. The fault trace with associated soft and loose material crosses the foundations diagonally from the upstream left corner of Monolith 11 to the downstream left corner of Monolith 12 (see attached drawing). The area of severely disturbed rock appears to be up to 15 feet wide in some areas and is currently at approximately the same elevation as the Monolith 10 and 11 foundations. Water is entering the excavation through this disturbe zone at both the upstream and downstream ends. The rock at the downstream right corner of Monolith 12 appears fairly competent but probably would not pass a final inspection. What should have been a five-foot vertical step between Monoliths 11 and 12 is virtually nonexistent. The majority of the upstream left side of Monolith 12 is covered by the haul road leading into the pit, so the condition of the underlying rock is not known.

4. The existing conditions in the problem area were examined by representatives of the Pittsburgh and Huntington Districts. Representing ORHCD were Bill Woodburn, Resident Engineer; Red Hamric, Field Engineer; Pat Oshel, Geologist; and Dave Nugen, Project Geologist. Stuart Long, Chief of the Geology Section, and Bob John, Geologist, represented ORPED-G. After considerable discussion, the group agreed on the following plan of action:

a. Lower the Monolith 12 founding elevation from 990 to 985, the same elevation as Monoliths 10 and 11. This will require drilling and blasting along the perimeter of the monolith and associated shifting of the existing haul road from one end of the excavation to the other and back again.

b. Excavate the soft and broken material in the fault trace with earthmoving equipment and hand tools in accordance with Section 2D of the specifications. This will also require pumping out the water. Since the fault dips down into the abutment, the cleanup should be done with care so as not to make the situation any worse under the left side of Monolith 12.

c. After cleaning out the fault area, carefully place dental concrete to foundation grade. It is anticipated this will effectively cut off any seepage path running under the dam.

d. Provide additional grout holes in the shear zone when grouting the foundation, if necessary.

5. Another potential problem area is the vertical step between Monoliths 13 and 14. The foundation for Monolith 14 is at elevation 1027 in a sandstone cap extending from 10 feet to 15 feet below the foundation. There is a continuous clay seam at the base of the sandstone, beneath which are weaker units such as siltstones and claystones down to the elevation of the Redstone Coal at approximately 1005. There is some concern about the portion of this face below the sandstone eroding back into the hillside. So far there has been only one incidence of major spalling directly below the sandstone. As a precaution, rock bolts have been installed across the face in a single line through the sandstone unit. Additional remedial measures will be done as conditions warrant.

6. Additional trips to Stonewall Jackson are planned following the lowering of Monolith 12 to elevation 985, probably in the week 15 April. The cleanup of the fault zone will be closely monitored.

Atch

STUART LONG
Chief, Geology Section

CF:
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ORHCD-L
ATTN: Resident Engineer
Stonewall Jackson Lake Dam

ORPED-G 25 April 1985

MEMORANDUM FOR RECORD

SUBJECT: Stonewall Jackson Dam Trip Report, Contract No. DACW59-83-C-0053

1. Reference memoranda on same subject dated 5 March 1984 through 17 April 1985.

2. The Stonewall Jackson Lake Dam project was visited on 15 April 1985 to inspect the progress of rock excavation in the Monolith 10 through 12 area. The foundation for Monolith 12 had been lowered five feet to elevation 985 as a result of discussions during the last site visit. (Reference MFR on same subject dated 17 April 1985.) The haul road and large pieces of rock had been removed from the pit and on the day of the visit the only equipment operating in this area was a backhoe excavating fault materials from the floor.

3. The fault in question has an approximate strike of N10°E, trending roughly from the upstream left corner of Monolith 11 to the downstream left corner of Monolith 12. It dips approximately 25° to 30°NW (down into the abutment) and is oriented such that it rises slightly toward the downstream end of the excavation. The fault daylights at the base of the downstream third of the Monolith 12/13 vertical face due to the combined effects of the orientation of the fault plane and the lowering of Monolith 12 to 985. The clay gouge and breccia zone appears to be approximately two feet thick on this face. Observations of the upstream and downstream faces and analysis of core boring data indicate the fault produced a vertical offset in the beds of around four or five feet.

4. The majority of the foundation of Monolith 12 was still covered with water so the condition of the floor is not known. The backhoe was excavating material from the fault zone through the duration of the visit. It appears that water removal will require at least two pumps. Water is entering primarily at the upstream and downstream ends of the excavation through the fault zone.

5. The Monolith 10 and 11 foundations were cleaned off fairly well. The foundation rock is a fine grained silty sandstone. No major problems are anticipated with these two monoliths, with the exception of the faulted portion of Monolith 11.

ORPED-G
SUBJECT: Stonewall Jackson Dam Trip Report, Contract No. DACW59-83-C-0053

6. The next site visit is scheduled for early in the week of 22 April. At that time, cleanup of Monoliths 11 and 12 should be at the stage where a more definitive investigation of the fault trace through the foundation should be possible.

Robert John

ROBERT JOHN
Geotechnical Branch

CF:
ORPED
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ORHCD-I
ORHCD-L
ATTN: Resident Engineer
Stonewall Jackson Lake Dam 2

ORHCD-1 26 April 85

MEMORANDUM FOR RECORD

SUBJECT: Stonewall Jackson Dam, Trip Report, Contract No. DACW59-83-C-0053

1. On 22 April 1985, Stu Long, Bob Johns, ORPED-G, David Nugen, Rodney Young, ORHCD-SWJ and H. P. Oshel, ORHCD-I visited the J. F. Allen Company Quarry near Elkins, West Virginia. The purpose of the inspection was to observe quarring operations and check for any shale contamination in the coarse aggregate. The quarry foreman showed us the two areas where aggregate for the project is being produced. After viewing the quarry faces, the rock produced from a recent shot and the coarse aggregate stock piles, we did not find any shale contamination. It is possible that some shale could get into the shot rock if the overlying shale beds are not completely removed in the area of the shot. We stressed the importance of not having any shale in the aggregate to the quarry foreman.

2. On 23 April 1985 an inspection was made of the fault that exists in the foundation of Monoliths 11 and 12. The foundation had been rough cleaned to grade. The trace of the fault was easily observeable across Monoliths 11 and 12, generally diagonally from the upstream right corner of Monolith 11 to the downstream left corner of Monolith 12. It was decided to remove as much of the soft, faulted material as possible in order to found on firm undisturbed rock. The fault excavation and dental concrete back fill will be accomplished in two sections. The first being Monolith 11 and a few feet into 12 and then the remainder of Monolith 12. Excavation was initiated while we were on site. The excavated area is approx. 6-10 feet wide and 3-4 feet deep. The majority of the excavation was done with a backhoe and considerable hand cleaning will have to be done in order to have an acceptable placing surface. The right side of the excavation follows a firm, sloping rock surface and the left side will be a near vertical cut. It appears that his will produce a satisfactory founding grade.

3. We also discussed the control of approx. 150-200 GPM of water that is coming into the excavation through the faulted material and open seams in the rock, mostly through the vertical face between Monoliths 12-13 and the upstream face of Monoliths 11 and 12. It is planned to channel the water into sumps, install a 24 inch CMP riser, pump out the water during concrete placement and then back fill the pipe and sump with tremie concrete.

H. P. Oshel

H. P. OSHEL
Geologist

OPPED-C 6 May 1985

MEMORANDUM FOR RECORD

SUBJECT: Stonewall Jackson Dam Trip Report, Contract No. DACW59-83-C-0053

1. Reference memoranda on same subject dated 5 March 1984 through 25 April 1985.

2. The Stonewall Jackson Lake Dam and the quarry supplying aggregate for its construction, the J. F. Allen Company quarry near Elkins, West Virginia, were visited by Stuart Long, Chief of the Geology Section, and Robert John, Geologist, of the Geotechnical Branch on 22 and 23 April 1985. Also visiting the same days was Pat Oshel, Geologist, of ORHCD-I.

3. The quarry was being reinspected primarily because of an impression on the part of some recent visitors from ORPED that an objectionable amount of shale was present in the aggregate stockpiles at the site. In addition to Messrs. Long, Oshel, and John, the quarry was visited by David Hugen, Project Geologist, and Rodney Young, Concrete Technician from the project. Mr. Bill Long, quarry foreman, met us at the quarry and accompanied us on the inspection. The aggregate is being produced from the Greenbriar Limestone formation of Mississippian age. The quarry face inspected in 1982 and described in the Stonewall Jackson Concrete DM is still in operation and is supplying approximately one-half of the aggregate. They have opened another face up-dip of this face in the same formation and it provides the remainder of the stone. While there are shaly beds in the Greenbrier Limestone, these are being wasted and inspection of stockpiles both at the quarry and at the project revealed no objectionable amounts of shale or shaly material. Monitoring by project personnel of the quality of aggregate supplied will continue.

4. The progress of Stage II excavation was inspected on 23 April by Messrs. Long, Oshel, Hugen, and John. Of primary interest was the condition of the fault zone running through monoliths 11 and 12, mentioned in previous MFR's. A backhoe was working in the faulted area removing broken rock and clay gouge. Measured on a vertical face, the actual gouge and breccia zone is 1 foot to 3 feet thick, but the associated zone of highly fractured rock is much greater. The general configuration of the fault is shown on the attached drawing. It was decided to excavate the right side of the fault to a competent rock unit which dips down toward the abutment while leaving the left side as nearly vertical as possible (See drawing). At foundation grade, the fault zone narrows to approximately 4 feet in

width near the right center of Monolith 12 while being as much as 12 feet to 15 feet across in other areas. The backhoe was excavating as much as 4 feet or 5 feet below the original foundation grade 985 at the time of the visit. The water flowing into the area was removed by pumps. After some discussion it was decided to treat the fault in two stages. The first stage will involve removing fault materials and replacing them with dental concrete across Monolith 11 and up to that point in Monolith 12 where the fault narrows to 4 feet. The second stage will involve a similar treatment of the remainder of the fault in the Monolith 12 foundation. Any concrete placed below elevation 985 will be considered dental concrete.

5. Alternative methods for dealing with the water entering the excavation through the Monolith 12/13 vertical face were discussed. Red Hamric, Field Engineer, proposed a 24 inch riser pipe in the downstream left corner of Monolith 12 equipped with a pump to carry the water out of the excavation. This pipe would then be grouted when the lifts have risen above the head of water. Mr. Hamric also proposed placing a sheet of plastic against parts of the vertical 12/13 face to funnel water down the face and into the corner. This idea was abandoned in favor of a plan involving using the existing half circles in the vertical face left from the line drilling as natural drainage paths down the face. These would lead water into a pipe placed along the edge of the foundation which would eventually empty into the 24 inch pipe at the downstream corner. Grouting would be done after the first or second lift through another riser pipe leading into the pipe on the foundation edge from a point near its upstream end.

6. It was also mentioned that Monolith 12 is scheduled to receive uplift pressure cells as was done in Monoliths 5 and 8. Mr. Long suggested locating one or two uplift cells into the gouge zone. The hole through the gouge zone would be cased with slotted PVC pipe and the uplift cell protected with mason sand. Mr. Hamric indicated this would not be a problem.

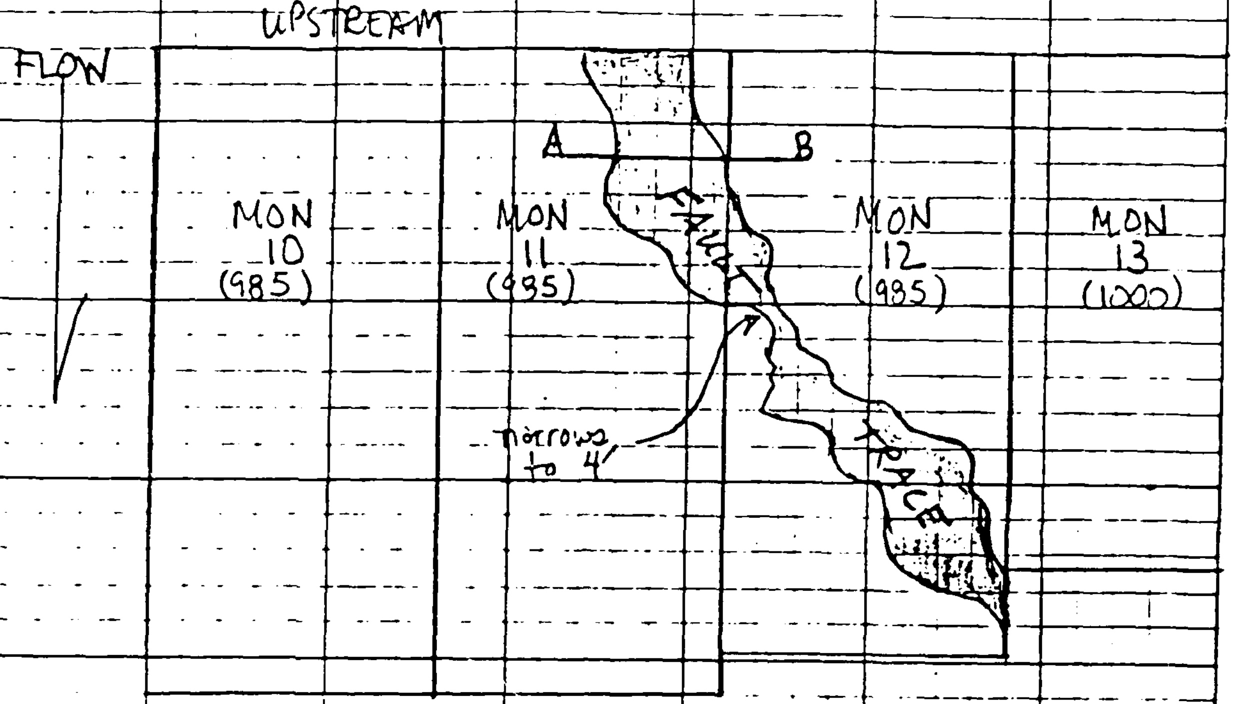
7. Additional site visits to the dam are planned to monitor the progress of foundation preparations.

Encl

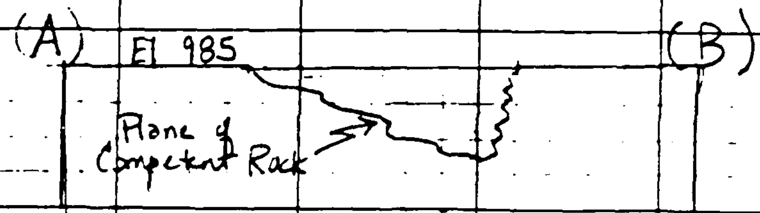
STUART B. LONG
Chief, Geology Section

CF:
ORPED
ORPED-G
ORPED-D
ORHCD-I
ORHCD-L
ATTN: Resident Engineer
Stonewall Jackson Lake Dam

OHIO RIVER DIVISION	DATE 30 APRIL 85	
INSTALLATION Pittsburgh	SUBJECT Stonewall Jackson Lake Dam	
COMPUTED BY RJ	COMPUTATION Fault in left abut.	NUMBER
CHECKED BY		



PLAN VIEW
SCALE: 1" = 25'



SECTION A-B SCALE: 1" = 10'

(Indicating fault materials being removed in gray)

ORPED-G 13 May 1985

MEMORANDUM FOR RECORD

SUBJECT: Stonewall Jackson Dam Trip Report, Contract No. DACW59-83-C-0053

1. Reference memoranda on same subject dated 5 March 1984 through 6 May 1985.

2. The Stonewall Jackson Lake Dam site was visited by Robert John of the Geotechnical Branch on 3 May and 6 May 1985 to inspect the continuing excavation of material from the fault that crosses Monolith 12 diagonally. As mentioned in Paragraph 4 of the 6 May MFR, the fault was being treated in two stages. Stage one was completed 25 April when dental concrete was placed in the excavated fault zone across Monolith 11 and in Monolith 12 to that point where the fault narrowed to 4 feet near the right center of the monolith. According to Dave Nugen, Project Geologist, approximately 49 cubic yards of dental concrete were required to fill the hole left by the fault excavation to foundation grade 985. By the time of this site visit, the first full lift of concrete had been placed on Monolith 11.

3. It was evident from the 3 May inspection that problems caused by the faulting are more severe in the Monolith 12 foundation than they had been in the Monolith 11 foundation. This is partially explained by the fact that the fault is a reverse fault dipping down into the abutment. That portion of the Monolith 12 foundation landward (left) of the actual fault trace is on the overthrust side and the rock has undergone more distress than rock on the footwall side, which comprises the majority of the Monolith 11 foundation and the downstream right corner of Monolith 12. The upstream face of the excavation to remove fault materials in Monolith 12 reveals only crumbly, broken siltstones and silt shales below the sandstone cap comprising the top 1' or 2' of the foundation. A 3" to 4" clay seam separates the sandstone cap from the underlying siltstones. Frequent clay seams within these siltstones and silt shales, probably offshoots from the major fault, continue back toward the upstream end of the monolith. Competent rock was found on the downstream side of the fault after removal of the gouge and breccia and it does not appear that this area will cause any major problems.

4. Also inspecting the foundation of Monolith 12 on 6 May were Pat Oshel, Geologist from ORHCD-I, Dave Nugen, Project Geologist, and Bill Woodburn, Resident Engineer. It was expected that the dental concrete would be placed on that day following final cleanup of the fault area. However,

ORPED-G
SUBJECT: Stonewall Jackson Dam Trip Report, Contract No. DACW59-83-C-0053

there remained concern over the potential for differential settlement and resultant cracking under the monolith due to poor foundation conditions upstream and to the left of the fault. At the request of Mr. Woodburn, placement of the dental concrete was postponed until Stuart Long, Chief of the Geology Section, could inspect the conditions.

5. Mr. Long arrived at the project 7 May 1985. Also present were Messrs. Oshel and Pugen. In a telephone conversation with Mr. Marshall Fausold, Chief of the Geotechnical Branch, following his inspection, Mr. Long indicated that the main options available were:

a. Place the dental concrete as originally planned and accept poor foundation conditions at the upstream end of the monolith.

b. Design a system to compensate for the poor conditions, such as reinforcing the base of the monolith with a mat of some kind.

c. Excavate the entire portion of the monolith to the left of the fault line down to below the fault.

It should be noted that this last option could involve a significant amount of excavation since the orientation of the fault is such that it occurs at approximately elevation 970 in the upstream left corner of Monolith 12 (as evidenced by existing boring 219).

6. The situation was discussed by Mr. Fausold, Mr. Joe Coletti, Chief of the Design Branch, Mr. Ed Kovanic, Chief of the Engineering Division, and Mr. Charlie Canning of the Ohio River Division, ORDED-G. It was decided to defer a final decision pending the drilling of five additional exploratory borings at the locations shown on the attached drawing by S. H. Mott, Inc. of Huntington, WV. Drilling is to commence 10 May 1985. After analysis of the core borings, the options will be reevaluated.

ROBERT JOHN
Geotechnical Branch

CF:

ORPED
ORPED-G
ORPED-D
ORMCD-I
ORMCD-L
ATTN: Resident Engineer
Stonewall Jackson Lake Dam

ORPED-G 17 June 1985

MEMORANDUM FOR RECORD

SUBJECT: Stonewall Jackson Dam Trip Report, Contract No. DACW59-83-C-0053

1. Reference memoranda on same subject dated 5 March 1984 through 13 May 1985.

2. The Stonewall Jackson Lake Dam was visited by Robert John of the Geotechnical Branch on 6 and 7 June 1985 to inspect the foundation and initial concrete placement of Monolith 13. This monolith was being placed a little earlier than expected, in light of the fact that Monolith 12 had been brought up to an elevation only slightly higher than the foundation elevation of Monolith 13 (elev 1000) rather than the typical one or two lifts.

3. The foundation rock for Monolith 13 is an interbedded siltstone and silty sandstone. Aside from a depression on the left side of the foundation and a trough along the right side adjacent to Monolith 12, there were no unusual features in this foundation. The depression on the left side of the foundation extended from 30 feet downstream of the axis to 60 feet downstream of the axis along the Monolith 13/14 joint and was approximately a half-oval in plan view. At its widest point, it extended 10 feet toward Monolith 12. It was approximately 2.5 feet deep along the 13/14 joint and sloped up to the right, apparently following the dip of the beds. The trough on the right side of the foundation was also two to three feet deeper than the rest of the foundation with a maximum five-foot lateral extent. Neither of these features posed a problem during concrete placement and they were not significant enough to require dental concrete.

4. The PVC pipes that had been placed at the downstream end of the Monolith 12/13 joint for the purpose of grouting a depression in that vertical face were cut off at elevation 1000 prior to setting the forms for Monolith 13. That grouting and grouting of four of the five additional borings in Monolith 12 and the upstream sump in Monolith 12 had been completed prior to this site visit. The sump in the downstream left corner of Monolith 12 and boring 228 on the upstream center line of Monolith 12 have yet to be grouted. Water is still flowing out of boring 228.

5. Additional trips to the project are planned to inspect the foundations for Monoliths 14 through 16 as concrete placement continues.

CF:
ORPED
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ORHCD-I
ORHCD-L
Attn: Resident Engineer
Stonewall Jackson Lake Dam

ROBERT JOHN
Geotechnical Branch

[illegible]

1[illegible] July 1985

MEMORANDUM FOR RECORD

SUBJECT: Stonewall Jackson Dam Trip Report, Contract No. DACW59-83-C-0053

1. Reference memoranda on same subject dated 5 March 1984 through 10 June 1985.

2. Stuart Long, Chief of the Geology Section of the Pittsburgh District Geotechnical Branch, visited the Stonewall Jackson Dam project on 9 and 10 July 1985 for the purpose of inspecting and approving foundation preparation of Monolith 14.

3. Foundation Preparation. The foundation rock for Monolith 14 is an interbedded siltstone and silty sandstone. Aside from infrequent low angle weathered jointing, the foundation rock was satisfactory for placement. The foundation grade was at approximate elevation 1027.5, 1/2 foot above design grade. This will produce a placement of three feet of concrete to elevation 1030. Monolith 13 had only been placed to elevation 1025, 2.5 feet below the foundation of Monolith 14.

Approval was given on 10 July to place concrete. However, at 0010 hours over two inches of rain fell at the project which resulted in cancellation of work. On 11 July, 272 yards of concrete were placed in Monolith 14.

4. Right Abutment Foundation Grouting. Dave Hugen, project geologist, had presented preliminary design changes to the right abutment surface grouting during a previous field trip. These modifications were discussed due to a request by the Contractor that consideration be given to changes in the sequence of construction and grouting. These changes have not been formally delivered to the Resident Engineer.

Basically, the Contractor wants to construct the filler concrete plug, the concrete retaining wall, and possibly the roadway adjacent to Monolith 1 before grouting the right abutment.

While there are no significant problems with allowing the right abutment surface grouting to be accomplished after the above items of work have been constructed, the Contractor should be made to accept the possible risks and the additional costs involved. These are as follows:

a. By drilling from a higher elevation, the quantities of grout pipe and grout to seal the grout pipes would increase.

[illegible]
SUBJECT: Stonewall Jackson Dam Trip Report, Contract No. [illegible]-C-0053

1. More control over grout pressures will be required to prevent uplift or damage to the completed structures.

If the Contractor addresses these risks, and that the additional cost of materials would be accepted by the Contractor solely for his convenience, and that any damage to the completed structures be repaired at no cost to the Government, then the proposal could be accepted.

5. Water Well for Dam. Consideration should be given to replacing the Contractor drilled well on the downstream left abutment with the sump left in the downstream corner of Monolith 12. This appears to be an excellent source of water both in volume and quality. (Based on clarity and taste.) It is suggested that samples be taken for water quality in order to evaluate this source of water for the dam.

6. Additional trips to the project are planned to inspect the foundations for Monoliths 15 and 16 as concrete placement continues.

STUART E. LONG
Chief, Geology Section

CF:

ORPED
ORPED-G
ORPED-F
ORHCD-I
Resident Engineer, Stonewall Jackson Lake
ATTN: ORHCD-Liaison

ORDED-GC 29 July 1985

MEMORANDUM FOR RECORD

SUBJECT: Stonewall Jackson Dam Trip Report, Contract No. DACW59-83-C-0053 and Tygart Dam Access Road Settlement

1. Reference memoranda on same subject dated 5 March 1984 through 18 July 1985.

2. Stuart Long, Chief of the Geology Section, and Barbara Matijevich, geologist of the Geotechnical Branch, visited the Stonewall Jackson Dam project on 18 and 19 July 1985 for the purpose of inspecting and approving foundation preparation of Monolith 15.

3. Foundation Preparation. The foundation rock for Monolith 15 is an interbedded moderately hard, dark gray claystone with calcareous inclusions and a moderately hard, medium gray, siltstone. The siltstone composed the minor exposure primarily along the base of the Monolith 15-16 step. The foundation rock was satisfactory for placement and approval was given on 19 July to place concrete.

The foundation grade was at approximate elevation 1038.5. This will produce a placement of approximately 6.5 feet of concrete to elevation 1045. Monolith 14 had only been placed to elevation 1035, 3.5 feet below the foundation of Monolith 15.

4. Tygart Dam Access Road Settlement. At the request of Gordon Loudin, Asst Resident Engineer, Stonewall Jackson Project Office, the undersigned visited Tygart Dam on 19 July 1985, to investigate a reported slide in the right abutment access road to the crest of the dam. Mr. Pat Docherty, Area Manager for the Monongahela Area projects, was present during the inspection.

The upper access road, near the East Stairwell building, shows signs of cracking through the asphalt pavement and a measured settlement of over 4-inches, four feet from the right of center line. The cracking covers an area approximately 25 feet long by 13 feet wide and starts 20 feet from the downstream edge of the Stairwell building. The crack is a maximum of 1-inch wide, and is generally irregular in shape, covering nearly one half of the roadway (see attached sketch and photos).

ORPED-GG 10 October 1985

MEMORANDUM FOR RECORD

SUBJECT: Stonewall Jackson Dam Trip Report, Contract No. DACW59-83-C-0053

1. Reference memoranda on same subject dated 5 March 1984 through 29 July 1985.

2. Robert John, geologist, of the Pittsburgh District Geotechnical Branch visited the Stonewall Jackson Dam project on 17 and 18 September 1985 for the purpose of inspecting and approving the foundation preparation of Monolith 16. He was met there by David Hugen, project geologist.

3. The foundation rock for Monolith 16 is a moderately hard interbedded siltstone and fine grained sandstone. The foundation grade was at approximately elevation 1060. The major problems noted with this foundation were thin red clay seams on some bedding planes and frequent near vertical joints spaced from 6 inches to 4 feet apart. Removal of drummy sounding rock caused by these clay seams required a good deal of time. The joints trended roughly north-south and while they were numerous, the width and depth of their associated weathered zones were not as great as with most of the joints found in other foundations. However, there was an open joint up to 2 inches wide terminating toward the upstream end of the Monolith 15 face that would require cleaning and backfilling with grout prior to concrete placement. There was a depression at the upstream right corner of the monolith, partially due to the weathering effects of this joint. Also, burlap and pieces of wood were noticed along the edge of the Monolith 15 face at foundation grade. The clean-up crews were directed to remove these as part of their foundation preparation.

4. The gallery form work for Monolith 16 had yet to be set and concrete placement was scheduled for 19 or 20 September. Except for last minute clean-up procedures, the foundation looked good and it was not considered necessary to stay at the project for concrete placement.

5. This is the last foundation inspection scheduled for Stonewall Jackson Dam. Grouting of the foundation is expected to commence sometime around January 1986.

ROBERT JOHN
Geotechnical Branch

CF:
ORPED
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ORPED-[illegible]
ORPCO-[illegible]
[illegible]
[illegible] Engineer
[illegible] Jackson [illegible] Dam

(R-101)

30 December 1985

MEMORANDUM FOR RECORD

SUBJECT: Routing Slip & Transmittal Slip dated 19 Dec 1985 concerning the Foundation Grouting Program for Stonewall Jackson Dam

As noted in the transmittal slip there are no prior contractor submittals required in the contract specifications concerning the grouting program. At present, neither the contractor nor his subcontractor has mentioned any problems with complying with the specification requirements of Section 20 of the contract.

There was an informal meeting here at the job site two weeks ago with the subcontractor, Pennsylvania Drilling Co. Discussed at this meeting with Jim Jones, Supervisor and "Snuffy" Smith, Grouting Specialist, were the following:

(1) Drills - Electric driven - hydraulic
(2) Grout Plant - Located on abutment; pumping to agitator located inside gallery from which pressure grouting will be performed.
(3) Cement - furnished in bags
(4) Work Sections - Determined with equipment and personnel known.
(5) Starting Date - Middle of January 1986

The above general information will be confirmed and additional, specific details concerning the grouting program determined when the subcontractor has mobilized.

Warren D. Nugen
WARREN D. NUGEN
Geologist

CF:
ORHCD-L

ORPED-GG 5 March 1986

MEMORANDUM FOR RECORD

SUBJECT: Stonewall Jackson Dam Trip Report, Contract No. DACW59-83-C-0053

1. Robert John, geologist, and Stuart Long, Chief of the Geology Section of the Geotechnical Branch, visited the Stonewall Jackson Lake Dam project on 20 and 21 February 1986 to inspect the progress of foundation grouting currently underway at the project. They were met at the project by Pat Oshel, geologist from ORHCD-I and David Nugen, project geologist, who is supervising the grouting.

2. The subcontractor performing the drilling and grouting operation is Pennsylvania Drilling Co. of Pittsburgh, PA. They have been at the site since approximately the first week of January. The holes in the gallery are angled 20° upstream and 20° toward the abutment, producing an actual angle of approximately 27° measured on a plane 45° from the dam axis. Pipes for the primary and secondary holes were set at the appropriate angle in the gutter of the drainage gallery at the time the monoliths were placed. Pennsylvania Drilling then drills the 1-3/8-inch diameter holes through these starter pipes with either a CP-65 (Chicago-Pneumatic) rig or one of the electric rigs they purchased from the Gearmec Company of Sweden. The grout hoses are attached to the nipples through a threaded connector being used in lieu of packers.

3. The Contractor is currently working on the grout holes angled toward the right abutment. Mr. Nugen has divided the right battered holes into four sections, numbered 1, 2, 3, and 4 as shown on the attached drawing. The curtain is also divided vertically into two zones. Within each zone there are stages, the depth of which depends on geologic conditions encountered during drilling such as loss or gain of drill water in appreciable amounts. If no unusual conditions are encountered, the entire zone is drilled as one stage. Holes in each section are drilled, pressure tested, and grouted in the following sequence - Zone 1 primary holes, Zone 1 secondary holes, Zone 2 primary holes, and finally Zone 2 secondary holes. To date, no tertiary holes have been required. Each section is drilled and grouted to completion before beginning an adjacent section. A minimum 100-foot spacing is maintained between drilling and grouting operations. The grout plant is presently located outside the Monolith 5 adit, with lines running down to a smaller agitator and Moyno pump in the gallery. The hopper of this unit holds 5.6 cubic feet of grout.

4. As of the site visit, sections 1 and 3 were complete. The primary holes in remaining sections 2 and 4 are also complete. Generally speaking, the foundation appears to be tight. Grout takes have been small in the majority of primary holes and pressure testing has shown that grouting is not required in many of the secondary holes. An interesting phenomenon noticed is that many of the holes produced an artesian flow and a pressure of between seven and nine pounds, but when water pressure tested would not take any water. One possible explanation is that drilling is surcharging the formation.

5. In section 1 and 3, the first stage of the primary holes was stopped at depths ranging from two feet to four feet below the foundation. Grout takes ranged from zero to seven bags, with the exception of one very high take of 40 bags in one of the holes under Monolith 9. This method was abandoned for sections 2 and 4; most of those were drilled the entire depth of the zone although some holes did require two or more stages. As many as 16 bags have been required for grouting primary holes in Zone 1 in the abutment fan area (Section 4). No tertiary holes have been required yet but Mr. Long recommended that a tertiary hole be added if the secondary hole shows a take of five bags or more. Tertiary holes should also be considered in the area of the former riverbed if the primary holes show high take, even if secondary holes indicate no need for them. So far this has not been the case but additional grout takes are expected in the holes angled toward the left abutment, particularly in the faulted area under Monoliths 11 and 12. Inspectors are to watch the uplift pressure cells in Monolith 12 for changes brought on by water pressure testing and take action to prevent these cells from being grouted in the event they are effected. So far, the uplift cells in Monoliths 5 and 8 have not been effected by the grouting and continue to function.

6. The contract calls for NX size exploratory borings to be drilled to determine the effectiveness of the grouting in sealing foundation fractures or expanded bedding planes. So far, none have been drilled. The group discussed where these holes should be drilled. The tentative plan is to drill one hole from the surface in each abutment, at least one hole in an area that appears tight, a few in selected areas of high grout takes, and a few in the area between Monoliths 10 and 13.

7. A CAGE task group on grouting from WES and various Corps districts and divisions is planning a meeting at Stonewall Jackson on 18-19 March to review and discuss the computer aided grouting program in use at the project. The program is primarily a data storage system in which the applicable data from each grout hole is entered at the end of the workday. As such, the system is useful for presenting a summary of each hole's

characteristics and for preparing pay estimates, but is not being used for on-site decisions concerning grout mix, rates of placing grout, etc. Another site visit to the project is planned the week of 9 March to update the progress of the grouting and finalize the itinerary for this meeting.

Atch

ROBERT JOHN
Geotechnical Branch

CF:
ORPED - (Kovanic)
ORPED-G
ORPED-D
ORHCD-I
ORHCD-L
ATTN: Resident Engineer
Stonewall Jackson Lake Dam

ORPED-GG 17 April 1986

MEMORANDUM FOR RECORD

SUBJECT: Stonewall Jackson Dam Trip Report, Contract No. DACW59-83-C-0053

1. Reference memorandum on same subject dated 5 March 1986.

2. Robert John, Geologist, and Stuart Long, Chief of the Geology Section of the Geotechnical Branch, visited the Stonewall Jackson Lake Dam project on 8 and 9 April 1986 to inspect the progress of the foundation grouting currently underway at the project. David Nugen, project geologist, is supervising the grouting operation, which is being done by Pennsylvania Drilling Co.

3. With the exception of surface grouting landward of Monolith 1, grouting of the right side of the foundation is complete. Tertiary holes had been added from Monolith 1 through approximately Sta. 2+00 in Monolith 3 as a result of some relatively high grout takes in this area and a request by Mr. Long that tertiary holes be drilled to intercept vertical steps between monoliths. The latter tertiary holes indicate the vertical steps are tightly grouted. Four quaternary holes were required under Monolith 2 from Sta. 1+67 to 1+75 since the adjoining tertiary holes had a grout take of greater than five bags. Grout takes on the right side, in general, were surprisingly low.

4. Work is now progressing in the gallery on grout holes battered toward the left abutment. Mr. Nugen has the gallery divided into three sections - Section 5 (encompassing holes between stations 4+39 and 5+49), Section 6 (5+49 to 6+39), and Section 7 (6+39 to 7+35, including the abutment fan). Grout takes have been higher, but more in line with what was expected, on this side of the grout curtain. This is especially true of areas where the grout holes intersect the fault diagonally crossing the foundation of Monolith 12 as it dips down into the abutment. Drilling Zone 1 tertiary holes from Station 4+80 through Station 5+80 was recommended, noting the potential for extending the reach of tertiary holes if conditions encountered in the future warrant them. The first stage of the tertiary holes should be stopped five feet below founding elevation. The following table indicates progress to date on grouting the left abutment.

Section	Zone	Primary	Secondary	Tertiary	Quaternary
5	1	Complete	Complete	-	-
5	2	-	-	-	-
6	1	Complete	Complete	-	-
6	2	Complete	Complete	-	-
7 - abutment fan	1	Complete	Complete	-	-
7 - abutment fan	2	-	-	-	-
7 - from gutter	1	Complete	-	-	-
7 - from gutter	2	-	-	-	-

5. Mr. Long and Mr. Nugen both expressed some surprise that none of the holes have hit a large water passage yet. This relates to the large volume of water seen entering the downstream left corner of the Monolith 12 excavation prior to concrete placement. This water was directed into a 24-inch vertical corrugated metal pipe still open to the surface. There are thoughts of possibly using this as a water well for the project subject to water quality testing. There is the possibility that this water is coming from the mountain along passages downstream of the dam and would thus be unaffected by the foundation grouting. It was recommended that after grouting is complete, the water in this pipe should be pumped out and the recharge yield determined. The possibility of installing piezometers downstream of the dam in this area was also discussed.

6. Much of the discussion between Mr. Long and Mr. Nugen centered on how to approach the surface grouting required on the right and left abutments in terms of the procedures the Contractor has proposed in his 21 February 1986 submittal. It was learned that this proposal has been modified due to the removal of significant amounts of rock left of Monolith 16.

a. Right Abutment. Holes to be drilled from the surface are laid out on the road and turnaround as shown on the attached drawing. Pennsylvania Drilling has a truck-mounted drill rig parked in the turnaround but has not yet sent a crew to run it. The holes will basically follow a line formed by the expression of the abutment fan holes if they were on the surface (20° upstream). In addition to vertical holes, there will be two holes angled to the left (roughly paralleling the landward face of Monolith 1) and six holes angled to the right. An NX exploratory boring will be put down at Station 1+11 and will serve as a secondary grout hole when complete. The current proposal is to drill the primary holes to el 1020 and the secondary holes to 1054, except the two left angled holes which

would both go to 1040. If the primary holes warranted it, the secondary holes could also be extended to 1020. It was recommended that this grouting begin as soon as possible so that drain hole drilling can commence and that the casings be totally grouted in, so that no uplift of the concrete filler section will occur.

b. Left Abutment. At the time of the visit, the first lift of impervious fill section tying in the left abutment with Monolith 16 was being placed. The Contractor wants to use this area as part of the access road connecting to the H road tie-in. It is unknown at this point how far up the Contractor intends to bring the fill before starting the grouting operation. Regardless, the grouting will be done through casings augered through this fill, drilled one foot into rock, and grouted the full length. The direction and alignment of holes will correspond to the alignment of the abutment fan holes as in the case of the right abutment. Casings will be set at el 1082 with the bottom of the holes at el 1067. The holes would be angled 20° as shown on the attached drawing. In the event grouting is not done until the fill is brought up to just below roadway elevation 1102, the top two feet of casing shall be of the screw-in type so that it can be removed and reduce the effects of the casing on the road surface. The Contractor is currently compacting the fill, obtained from a borrow area upstream of the dam, with a large steel roller. A sheep's foot roller would be preferred. In addition, the Contractor should use a motorized hand tamper at the fill/concrete interface.

7. Additional site visits will be made as conditions warrant. To date, the grouting is proceeding very well, but the Contractor is anxious to begin drilling the drain holes. Mr. Long confirmed that the Contractor may start drilling the drains between Station 1+90 and 3+10, bearing in mind that these holes must be protected when drain hole drilling higher up in the gallery commences.

Atch

ROBERT JOHN
Geotechnical Branch

CF:
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ORPED-D
ORHCD-I
ORHCD-L
Attn: Res Engr, Stonewall
Jackson Lake Dam

SECTION 10

APPENDIX

10.2 EXHIBITS

Exhibit No.	Description
1	Project Location and Vicinity Map
2	General Plan
3	Rock Buttress Fill Plan
4	Stage I Cofferdams and Diversion
5	Stage II Cofferdams and Diversion A. Phase 1 B. Phase 2
6	Borrow and Spoil Area
7	Regional Geologic Basin Map A. Northern Section B. Southern Section
8	Generalized Geologic Section
9	Concrete Structures Foundation A. Stage 1 B. Stage 2
	Individual Monoliths 1. Monolith 1 2. Monolith 2 3. Monolith 3 4. Monolith 4 5. Monolith 5 6. Monolith 6 7. Monolith 7 8. Monolith 8 9. Monolith 9 10. Monolith 10 11. Monolith 11 12. Monolith 12 13. Monolith 13 14. Monolith 14

15. Monolith 15
16. Monolith 16
17. Monolith 17, 18, 19 (RL Training Wall)
18. Monolith 20, 21, 22 (LL Training Wall)
19. Stilling Basin

10 Impervious Fill

11 Grout Curtain

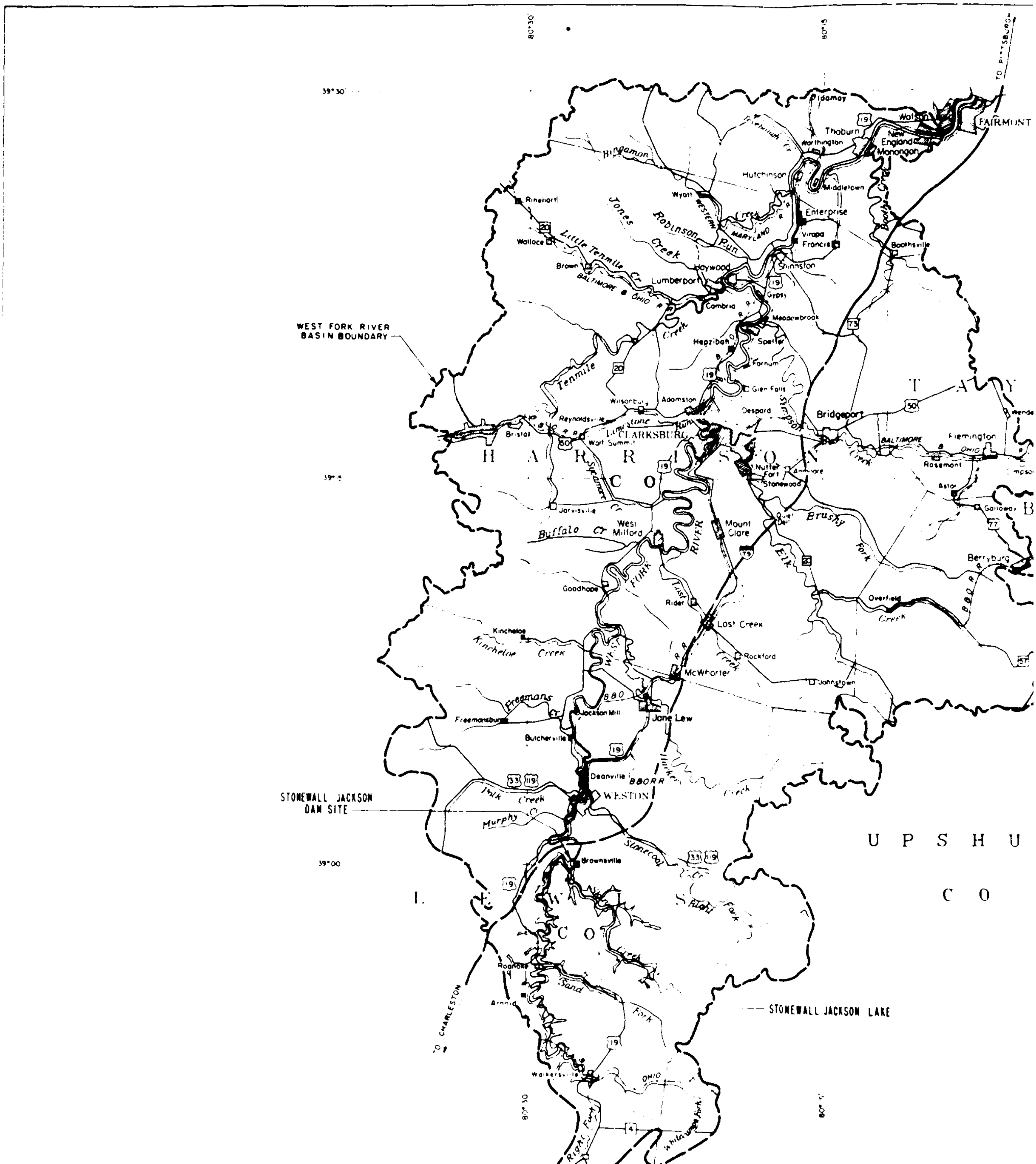
1. Sta. 1062.00 1111.50
2. Sta. 1125.00 1127.00
3. Sta. 1126.25 1196.25
4. Sta. [illegible] [illegible]
5. Sta. 2868.75 [illegible]
6. Sta. [illegible] [illegible]
7. Sta. [illegible] 5188.25
8. Sta. 5010.00 [illegible]
9. Sta. [illegible] [illegible]
10. Sta. [illegible] [illegible]
11. Sta. [illegible] [illegible]
12. Sta. [illegible] 6022.25

12 Drain Holes

1. Stilling Basin (Plan View)
2. Stilling Basin (Cross Section View)

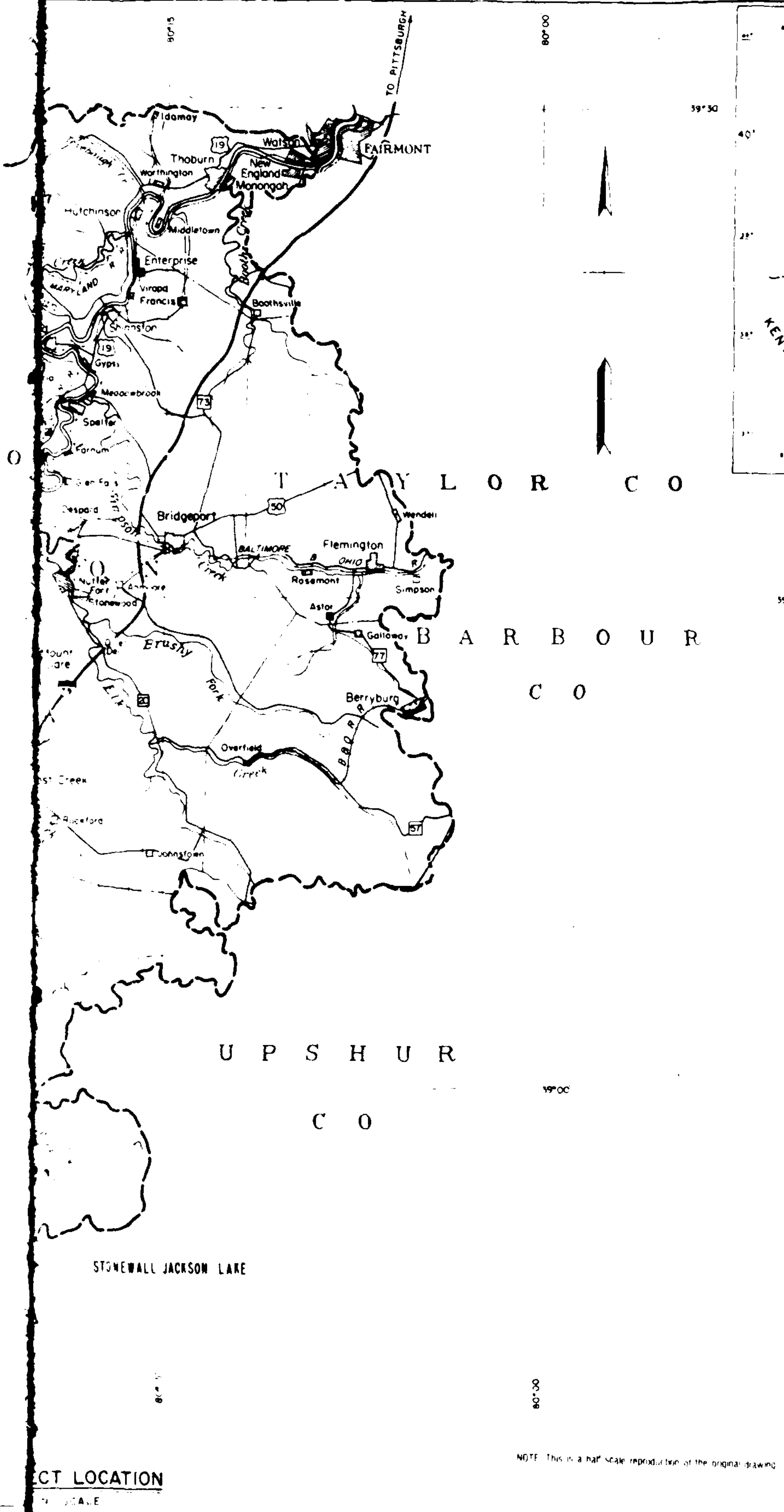
13 Subsurface Exploration

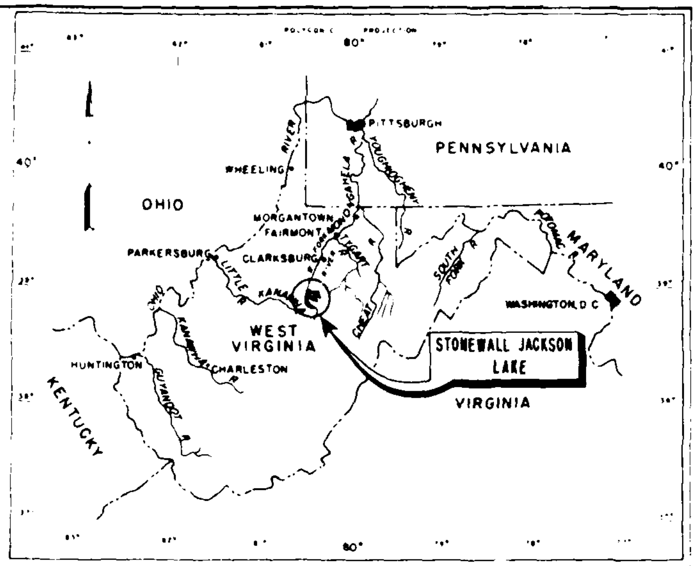
A. Pre-construction
B. During Construction



PROJECT LOCATION

NO SCALE





VICINITY MAP

SCALE IN MILES

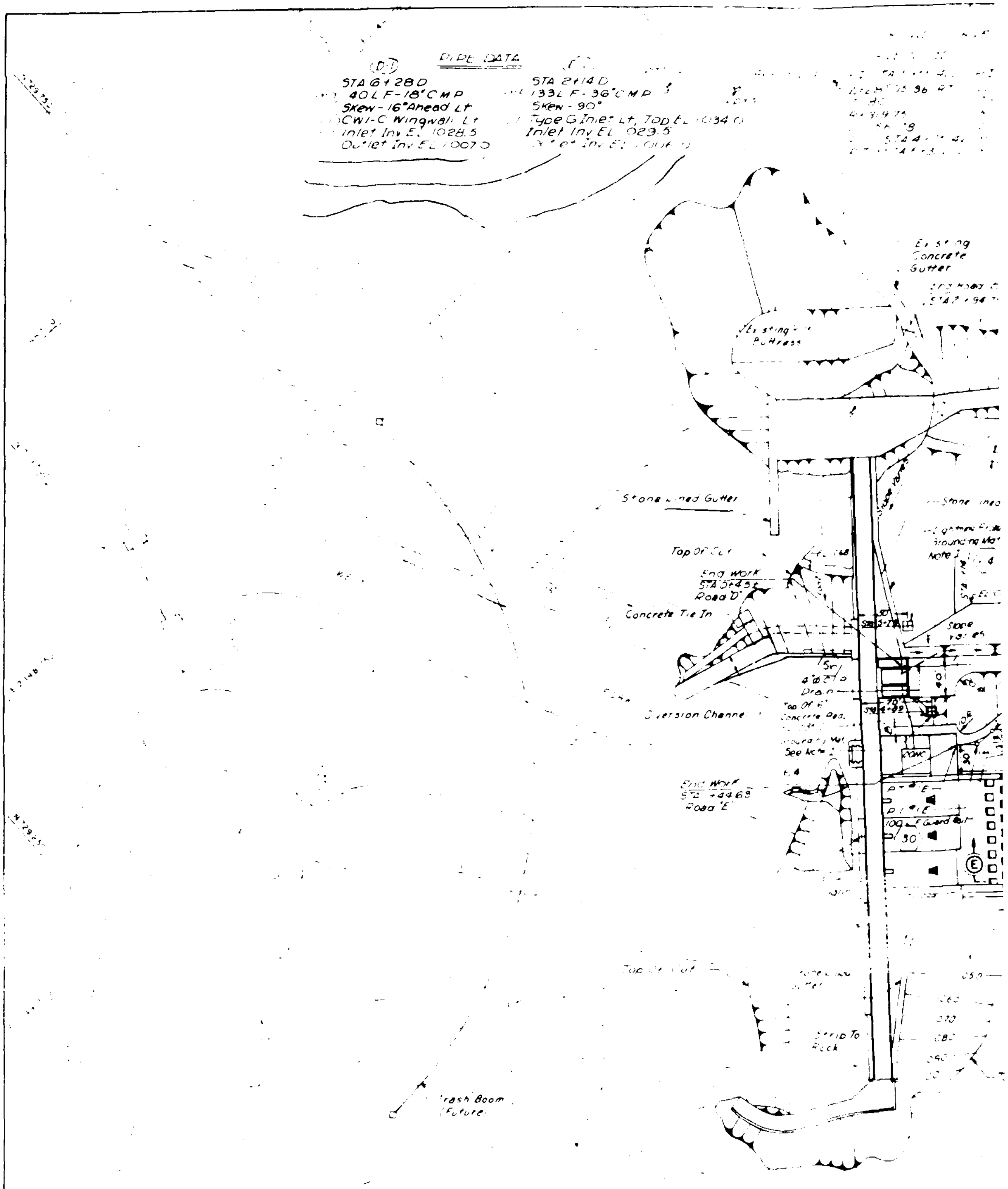
NOTE: This is a half scale reproduction of the original drawing

U.S. ARMY, HUNTINGTON DISTRICT
CORPS OF ENGINEERS

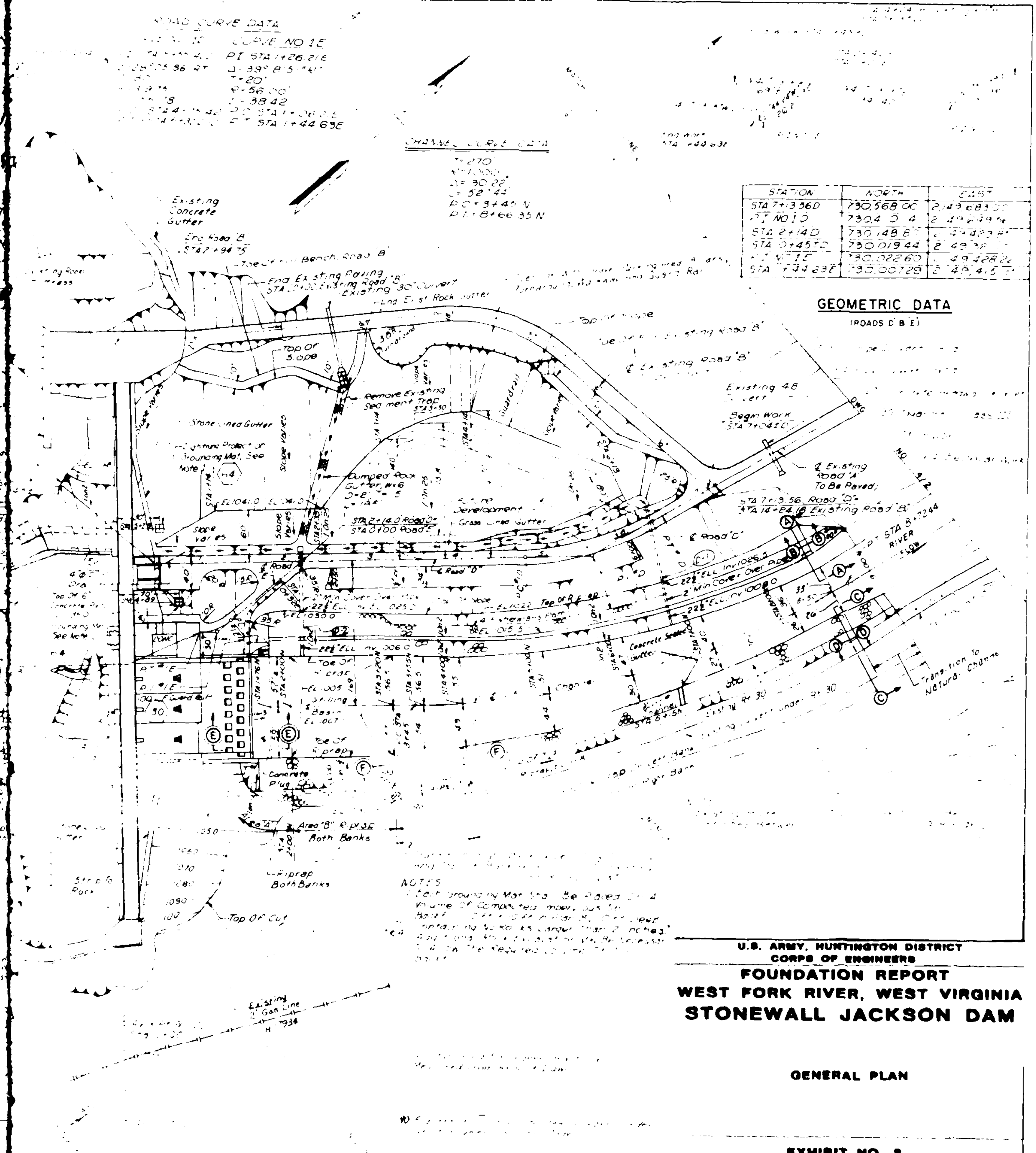
FOUNDATION REPORT
WEST FORK RIVER, WEST VIRGINIA
STONEWALL JACKSON DAM

PROJECT LOCATION AND VICINITY MAP

EXHIBIT NO. 1



AXIS OF DAM CONTROL STATIONS					
AXIS POINT	DISTANCE (FT)	STATION	ELEVATION (FT ABOVE NGVD)	COORDINATES	
			1094.75	[illegible] 68.4[illegible]	E2,149,[illegible]
2	[illegible] 93	[illegible]+00	1132.44	[illegible]729,643.00	E2,149,599.[illegible]
3	1113.34	[illegible] 3.20	1204.80	N730,[illegible]	E2,148,846.92
[illegible]	105.60	11+13.20		[illegible] 76	E2,148,778.32
[illegible]	[illegible]3.24	[illegible] 3.20		N730,[illegible]	E2,148,731.32

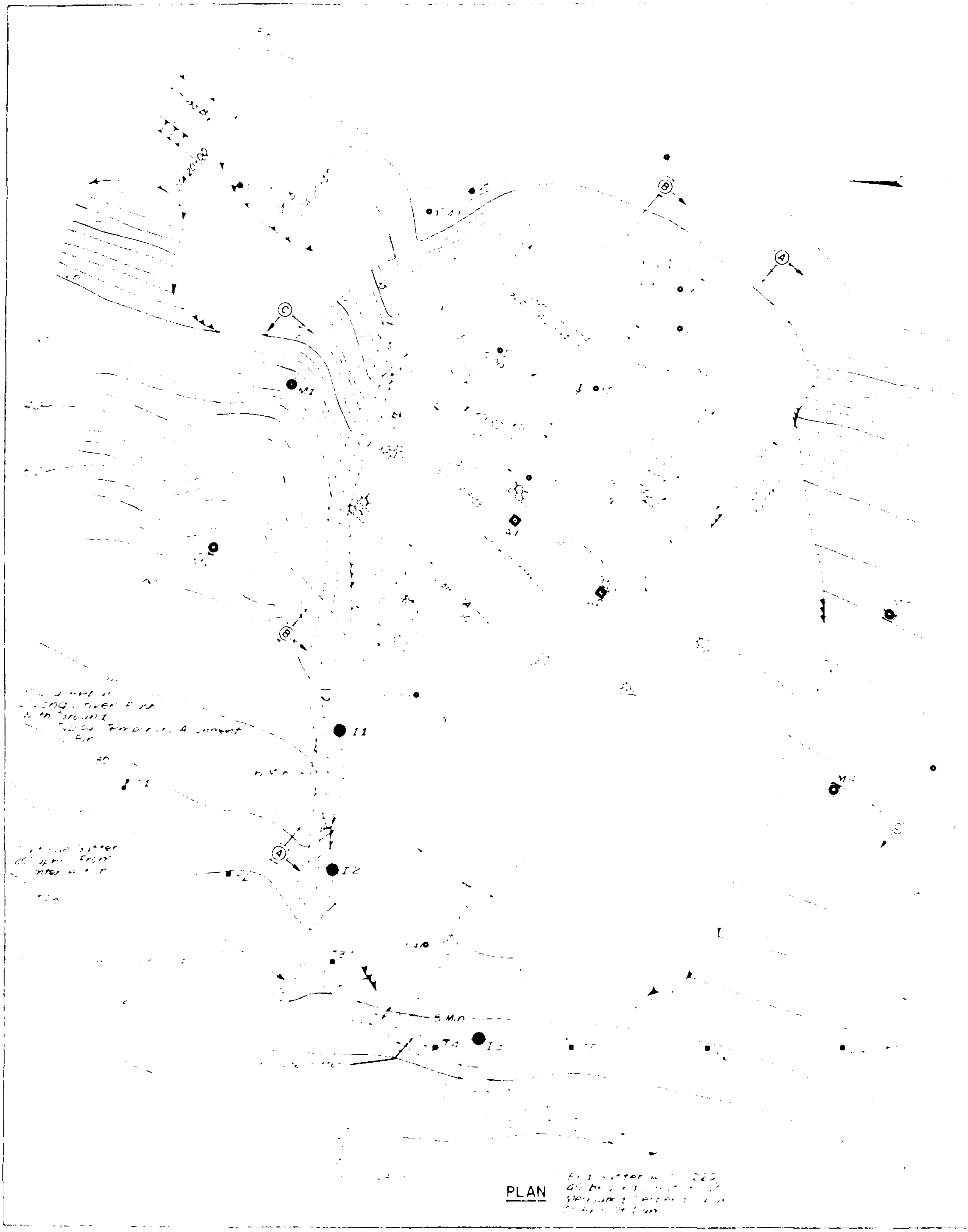


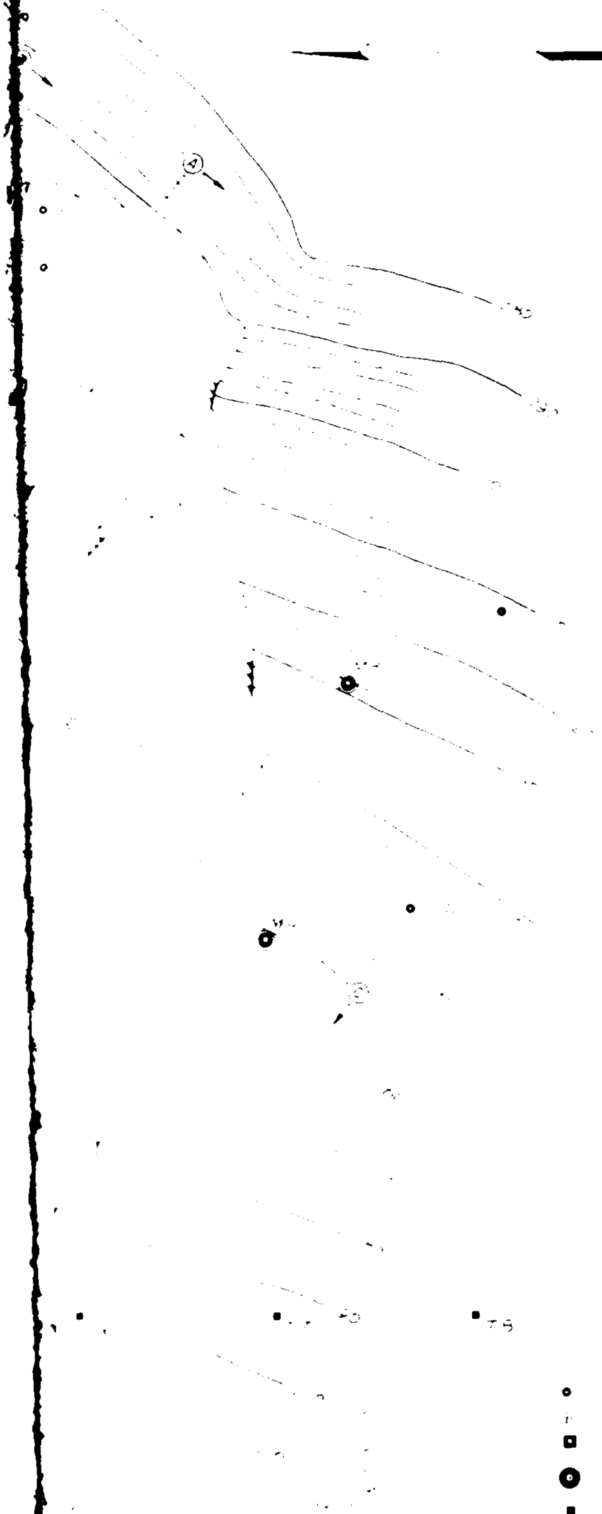
U.S. ARMY, HUNTINGTON DISTRICT
CORPS OF ENGINEERS

FOUNDATION REPORT
WEST FORK RIVER, WEST VIRGINIA
STONEWALL JACKSON DAM

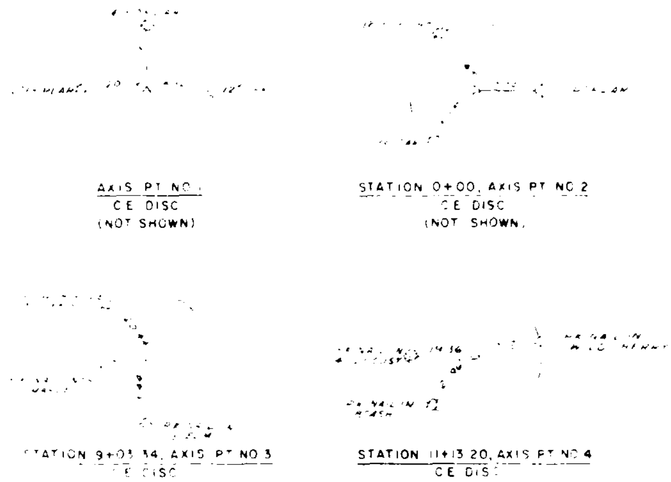
GENERAL PLAN

EXHIBIT NO. 2


PLAN



CONTROL STATIONS



AXIS OF DAM REFERENCES

LEGEND

- BORING LOCATION (EXISTING)
- C.E. DISC (EXISTING)
- ALIGNMENT PIN MONUMENT (THIS CONTRACT)
- REFERENCE MONUMENT (THIS CONTRACT)
- TEMPORARY ALIGNMENT PIN MONUMENT (THIS CONTRACT)
- [illegible] METER [illegible] (THIS CONTRACT)

U.S. ARMY, HUNTINGTON DISTRICT
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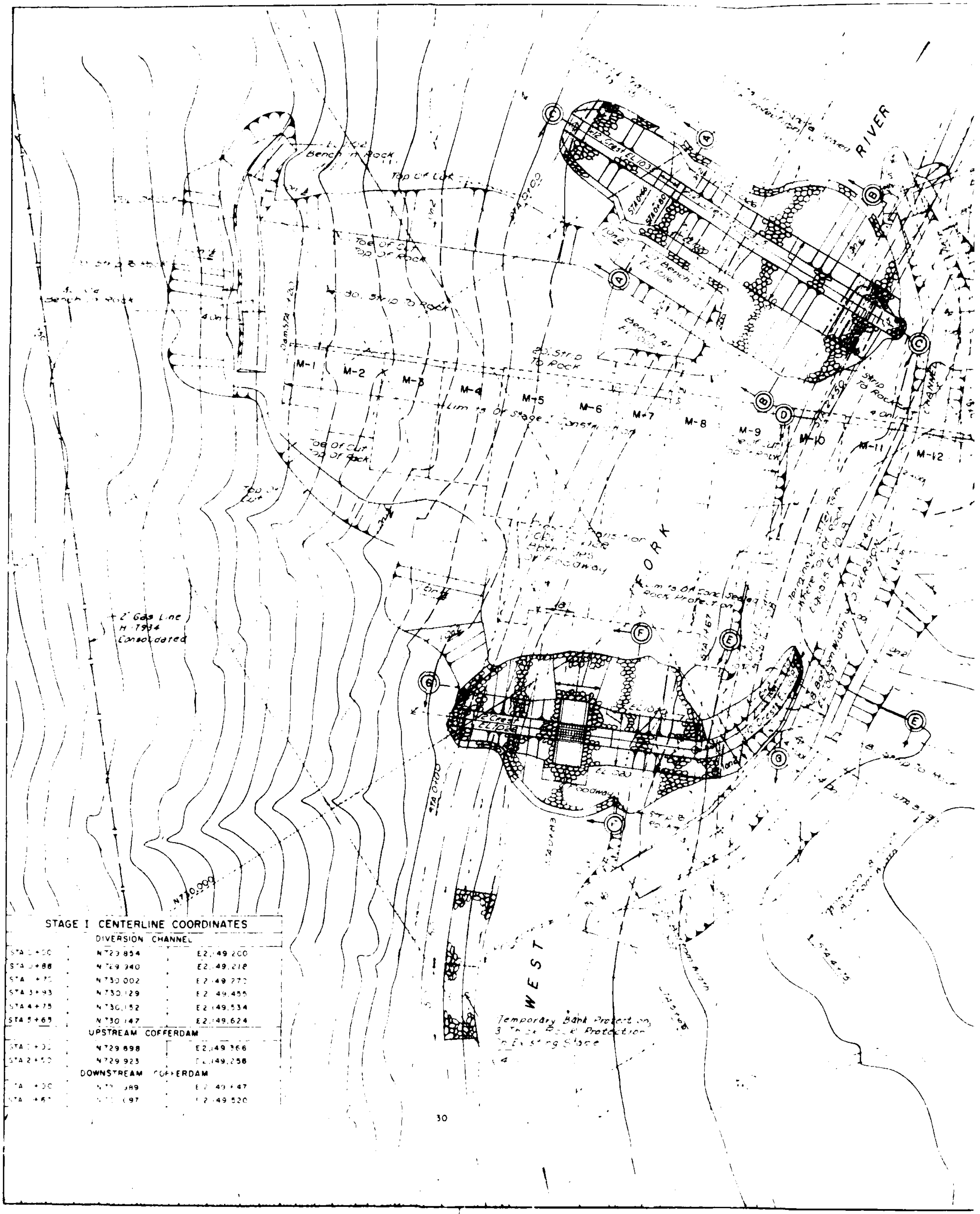
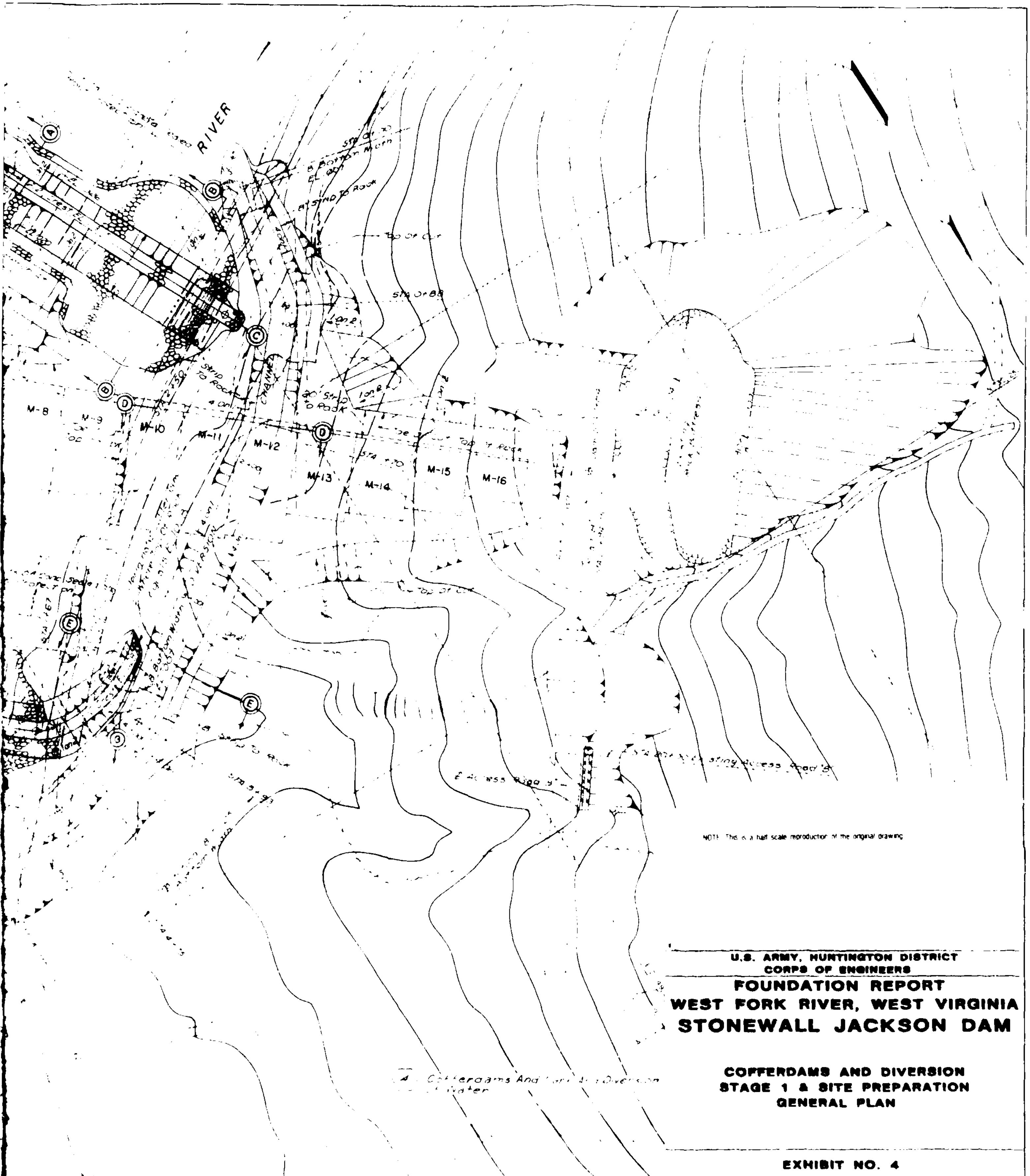
FOUNDATION REPORT
WEST FORK RIVER, WEST VIRGINIA
STONEWALL JACKSON DAM

ROCK BUTTRESS FILL
PLAN

EXHIBIT NO. 3



STAGE I CENTERLINE COORDINATES		
DIVERSION CHANNEL		
STA 0+00	N 723 854	E2,149 200
STA 0+88	N 729 340	E2,149,218
STA +75	N 730 002	E2,149 272
STA 3+93	N 730,129	E2 149,455
STA 4+75	N 730,152	E2,149,534
STA 5+65	N 730 147	E2,149,624
UPSTREAM COFFERDAM		
STA 0+00	N 729 698	E2,149 366
STA 2+50	N 729 923	E2,149,258
DOWNSTREAM COFFERDAM		
STA +00	N [illegible] 389	E2 149 447
STA +6[illegible]	N [illegible] 097	E2 149 520



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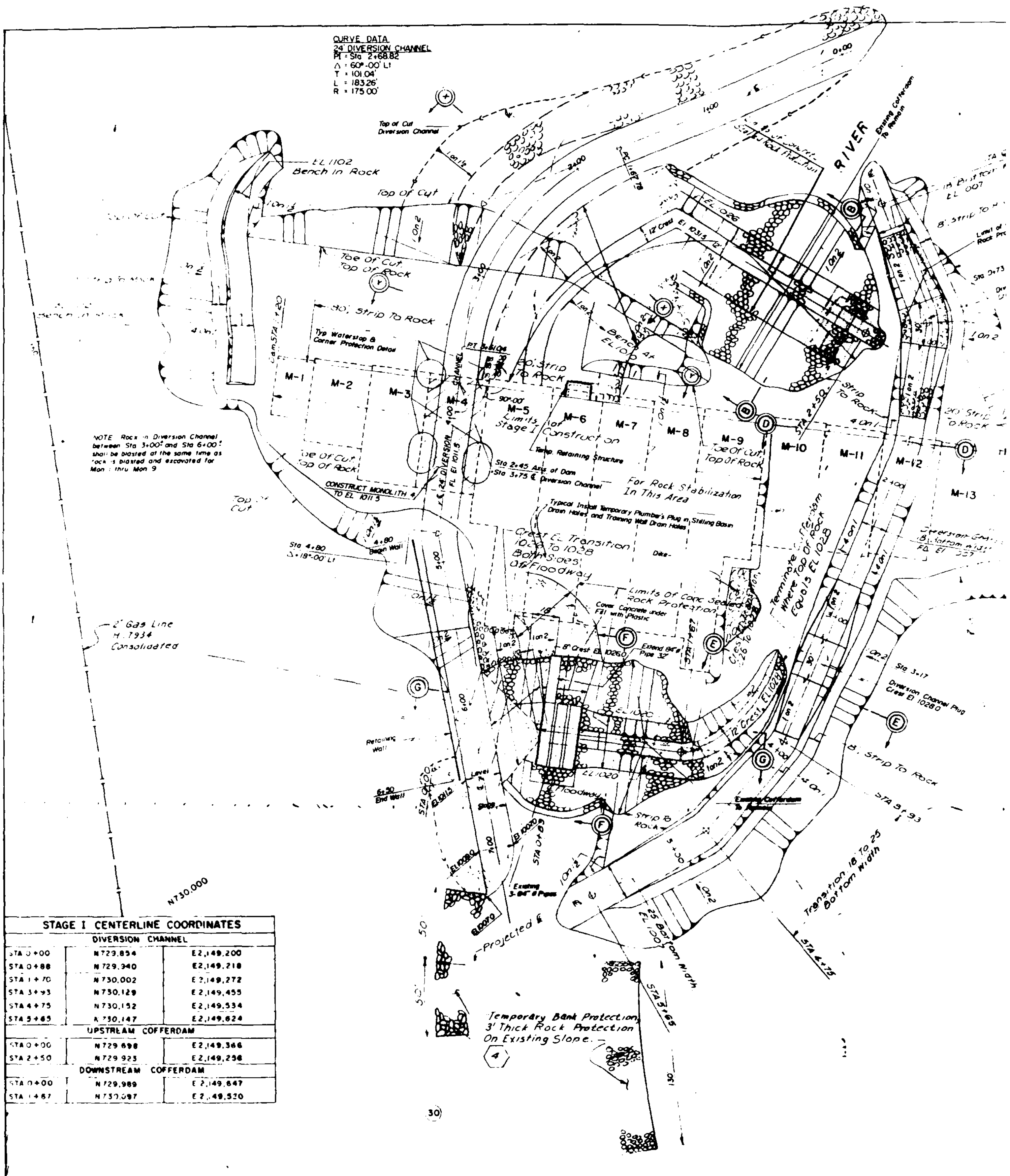
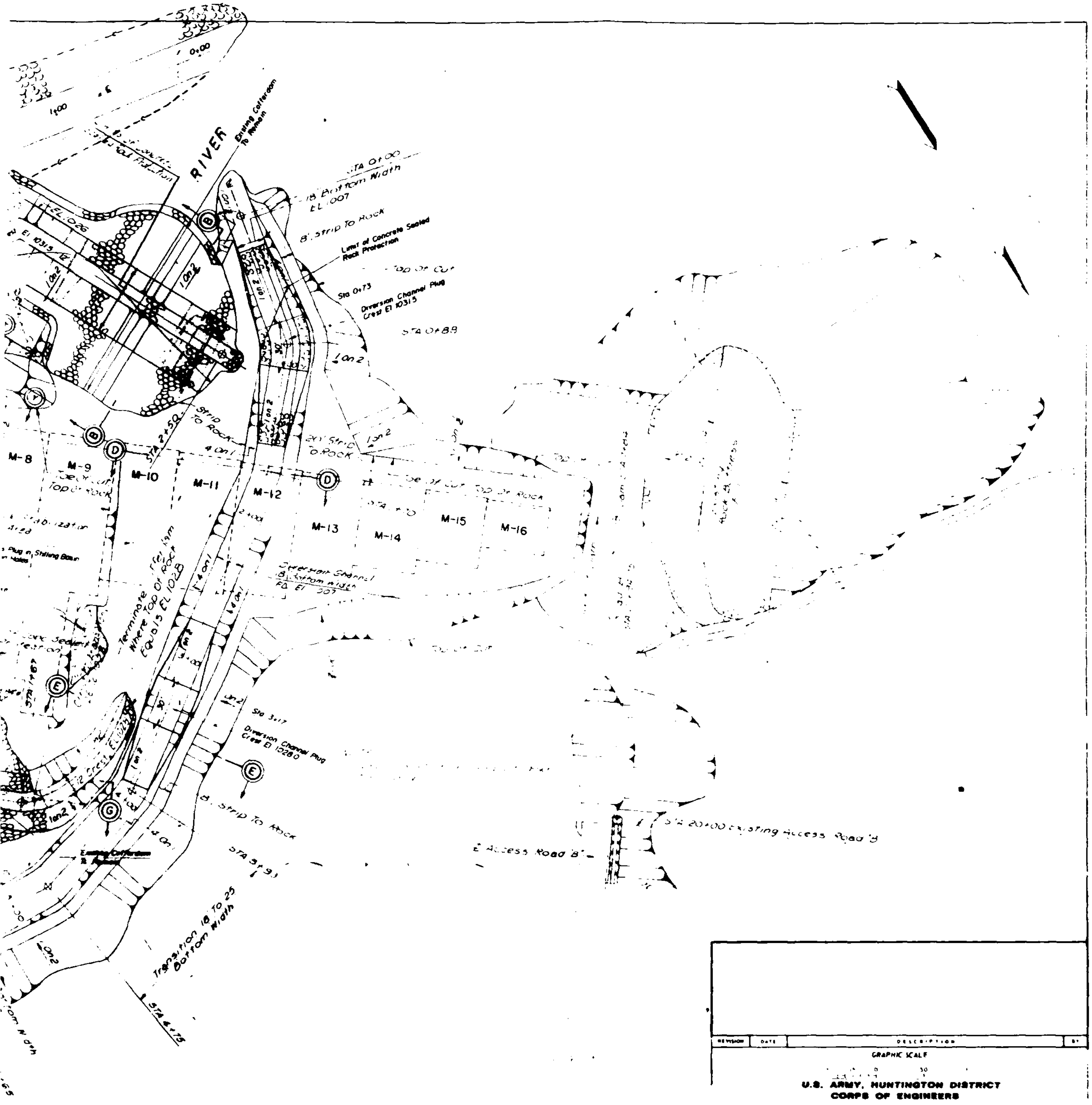
WEST FORK RIVER, WEST VIRGINIA
STONEWALL JACKSON DAM

COFFERDAMS AND DIVERSION
STAGE 1 & SITE PREPARATION
GENERAL PLAN

EXHIBIT NO. 4



STAGE I CENTERLINE COORDINATES		
DIVERSION CHANNEL		
STA 0+00	N729,854	E2,149,200
STA 0+88	N729,940	E2,149,218
STA 1+70	N730,002	E2,149,272
STA 3+93	N730,129	E2,149,455
STA 4+75	N730,152	E2,149,534
STA 5+65	N730,147	E2,149,624
UPSTREAM COFFERDAM		
STA 0+00	N729,698	E2,149,366
STA 2+50	N729,925	E2,149,256
DOWNSTREAM COFFERDAM		
STA 0+00	N729,989	E2,149,647
STA 1+67	N730,097	E2,149,520



REVISION	DATE	DESCRIPTION	BY

GRAPHIC SCALE

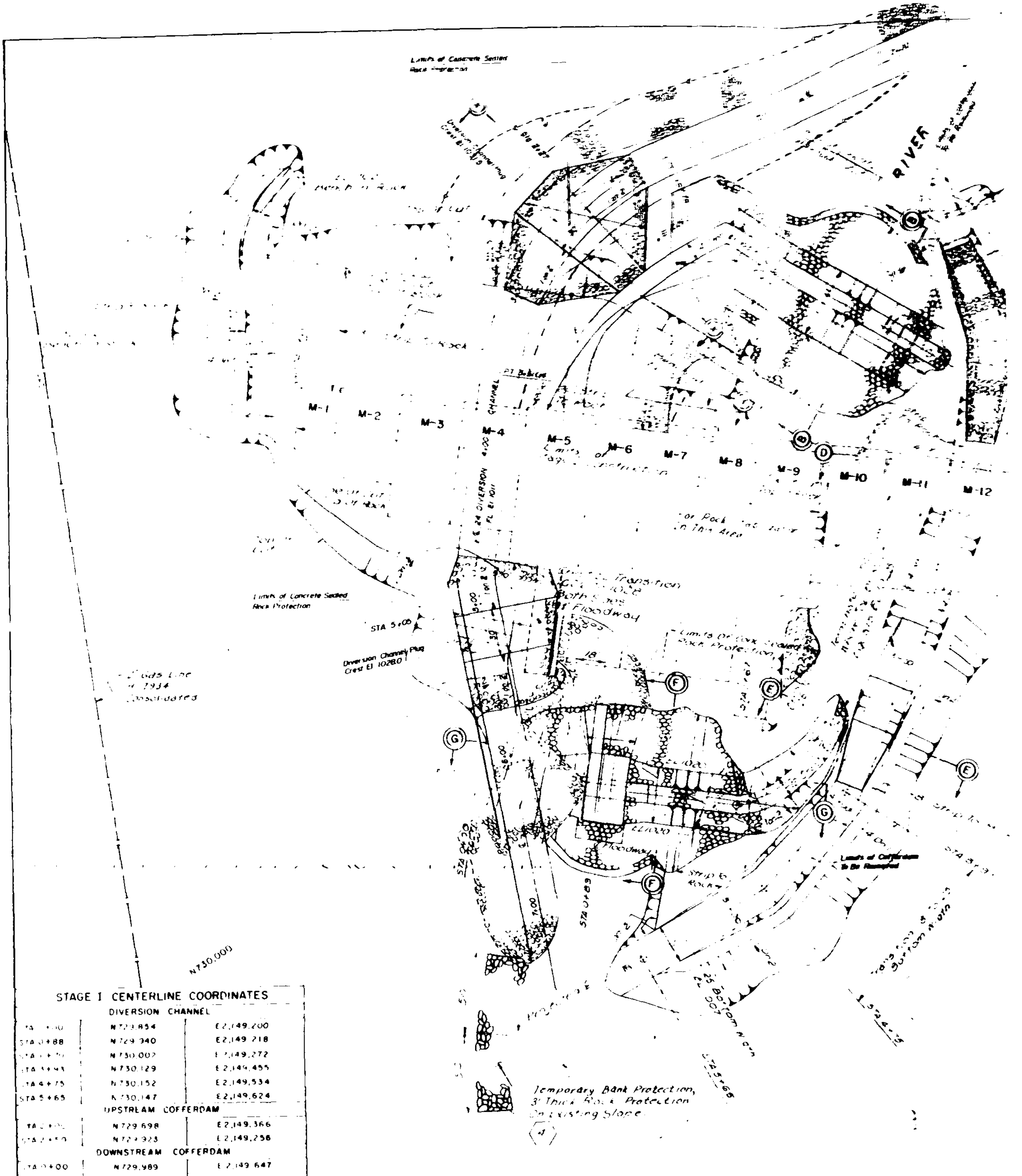
U.S. ARMY, HUNTINGTON DISTRICT
CORPS OF ENGINEERS

FOUNDATION REPORT
WEST FORK RIVER, WEST VIRGINIA
STONEWALL JACKSON DAM

COFFERDAMS AND DIVERSION
STAGE 2 - ALTERNATE PLAN
PHASE 1

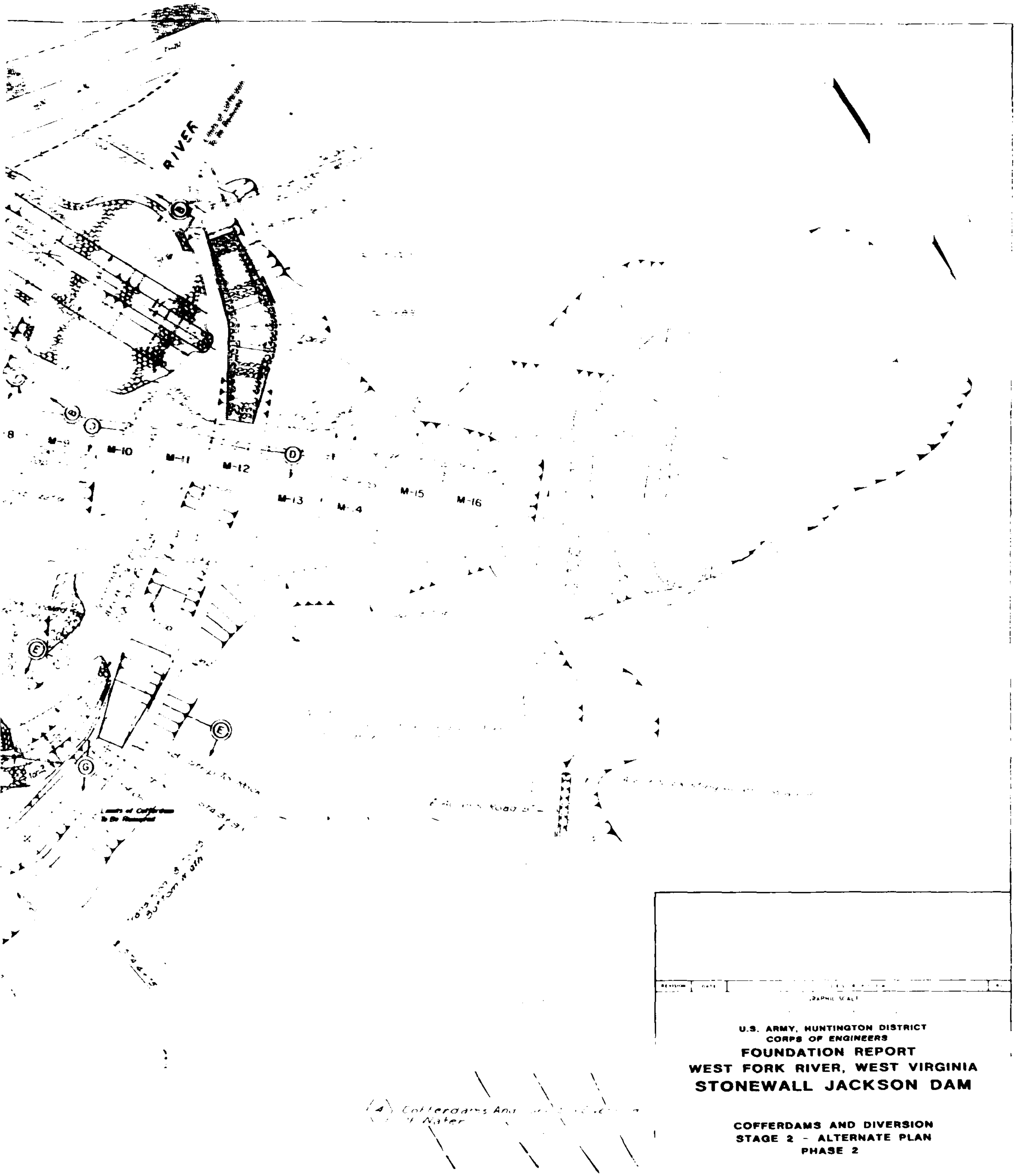
4 Cofferdams And Care Of Diversion Of Water

EXHIBIT NO. 5A



STAGE 1 CENTERLINE COORDINATES

DIVERSION CHANNEL		
STA [illegible]	N 7[illegible]3,854	E 2,149,200
STA 0+88	N 729,340	E 2,149,218
STA [illegible]	N 730,002	E 2,149,272
STA [illegible]	N 730,129	E 2,149,455
STA 4+75	N 730,152	E 2,149,534
STA 5+65	N 730,147	E 2,149,624
UPSTREAM COFFERDAM		
STA [illegible]	N 729,698	E 2,149,366
STA 2+50	N 72[illegible],323	E 2,149,256
DOWNSTREAM COFFERDAM		
STA 0+00	N 729,989	E 2,149,647
STA [illegible]+67	N 73[illegible],97	E 2,149,520



U.S. ARMY, HUNTINGTON DISTRICT
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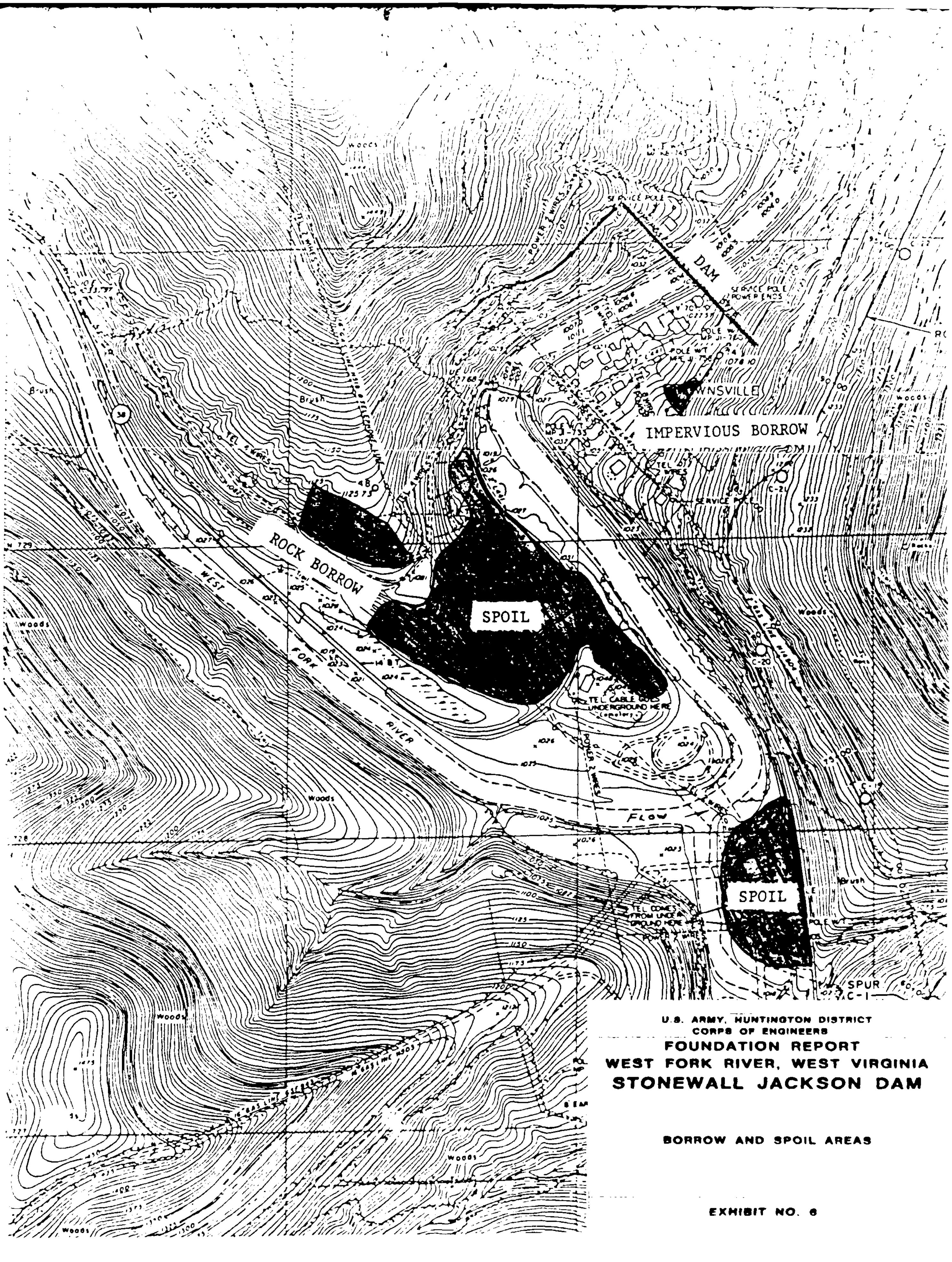
FOUNDATION REPORT
WEST FORK RIVER, WEST VIRGINIA
STONEWALL JACKSON DAM

COFFERDAMS AND DIVERSION
STAGE 2 - ALTERNATE PLAN
PHASE 2

EXHIBIT NO. 5B



U.S. ARMY, HUNTINGTON DISTRICT
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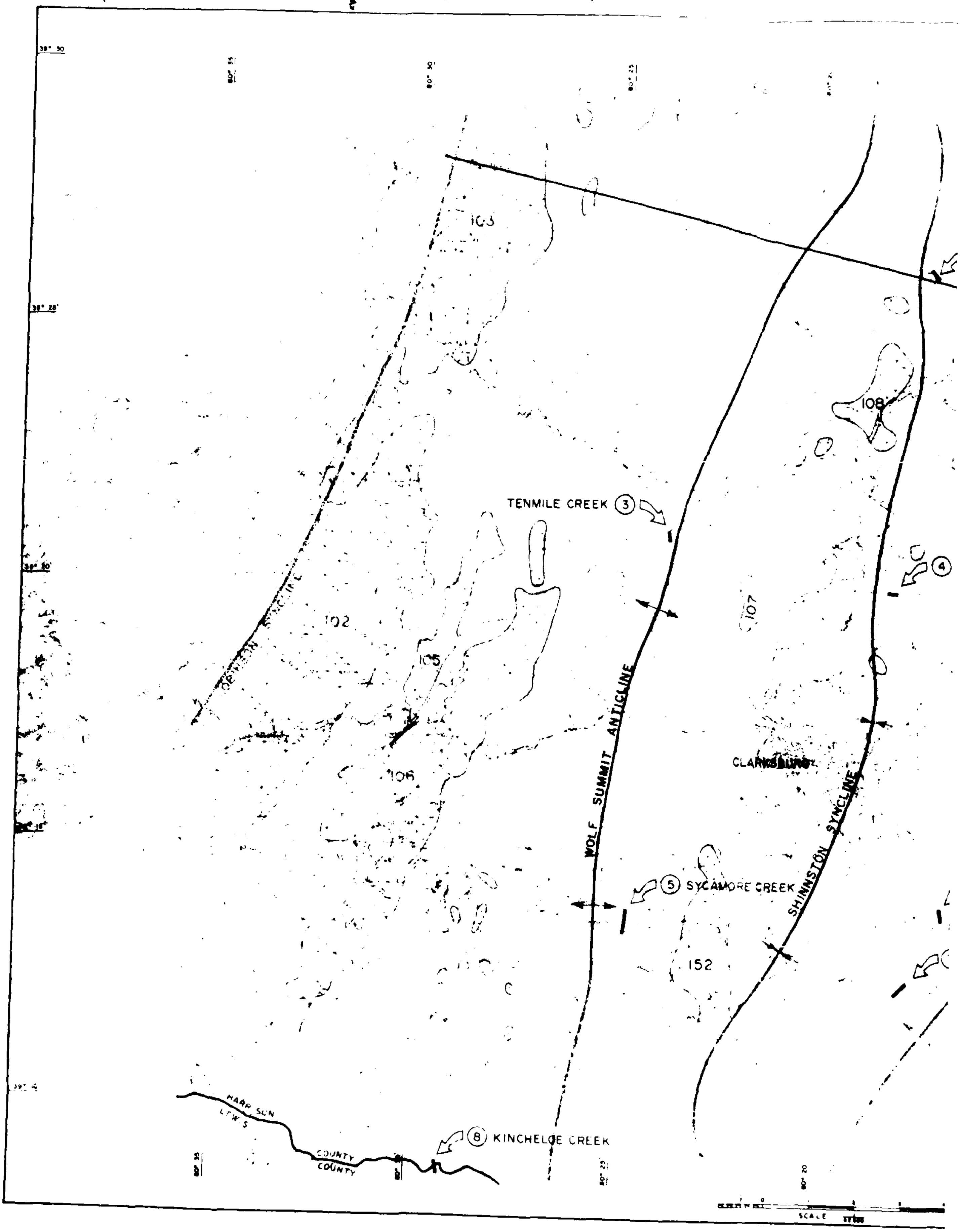
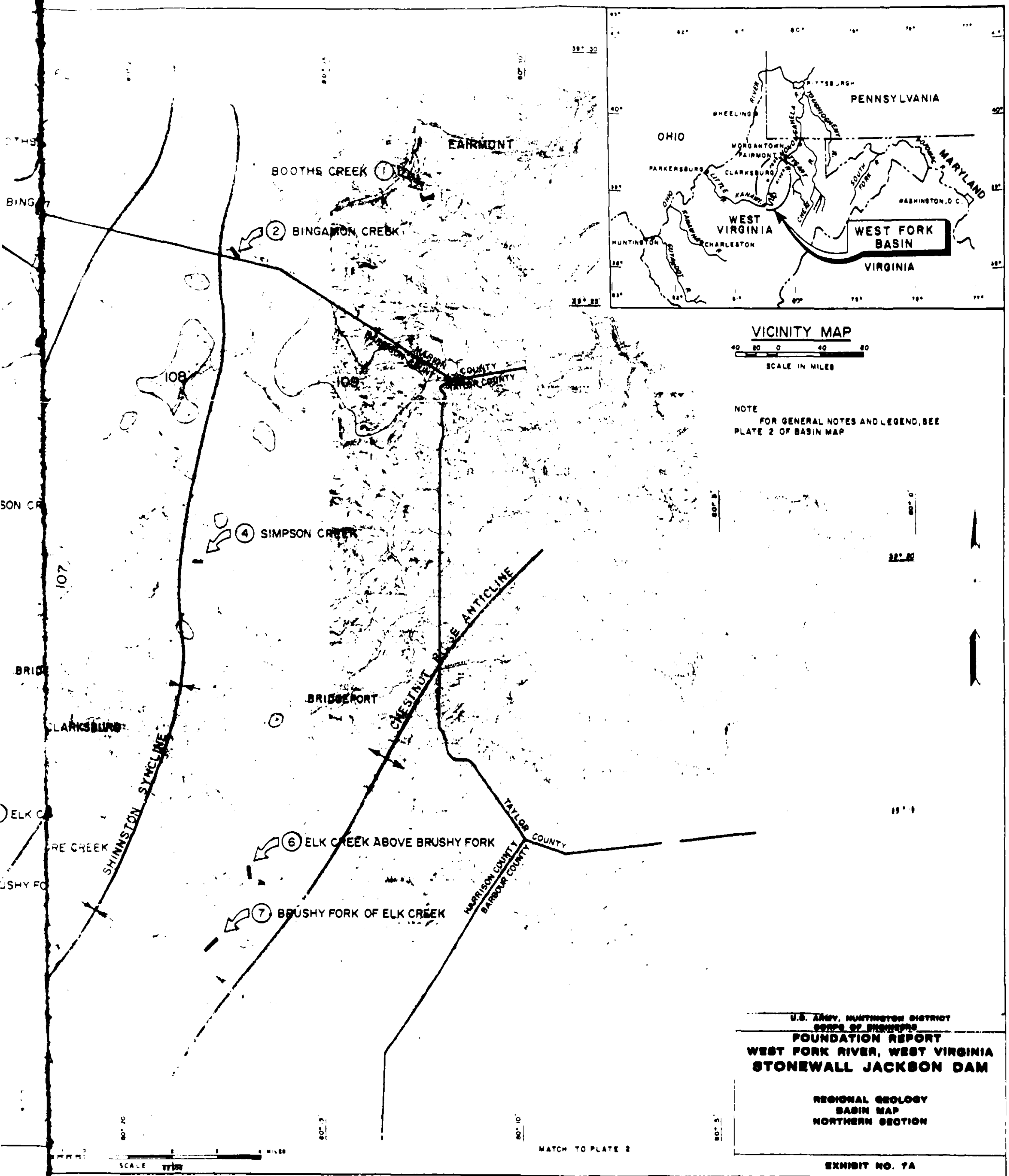
FOUNDATION REPORT
WEST FORK RIVER, WEST VIRGINIA
STONEWALL JACKSON DAM

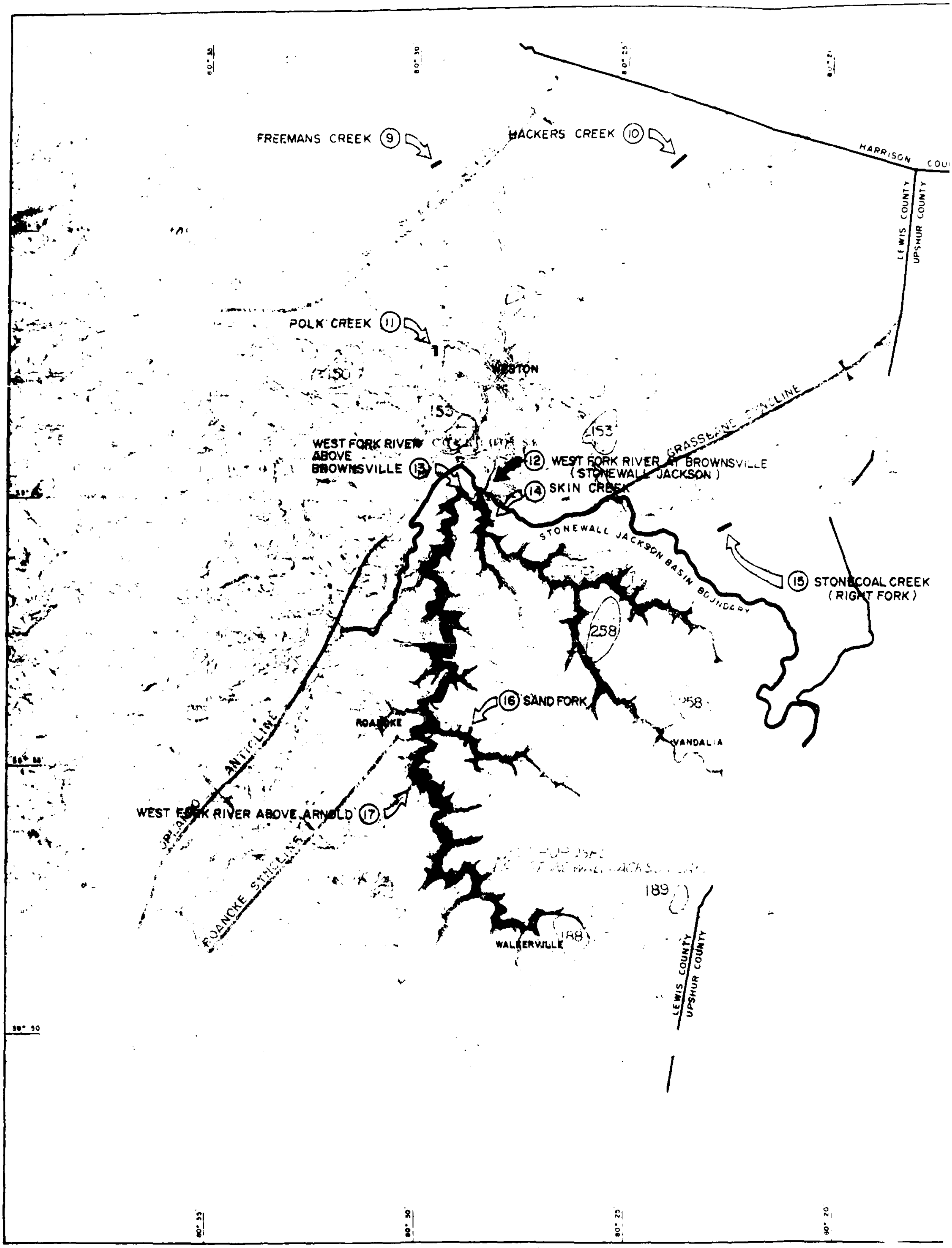
BORROW AND SPOIL AREAS

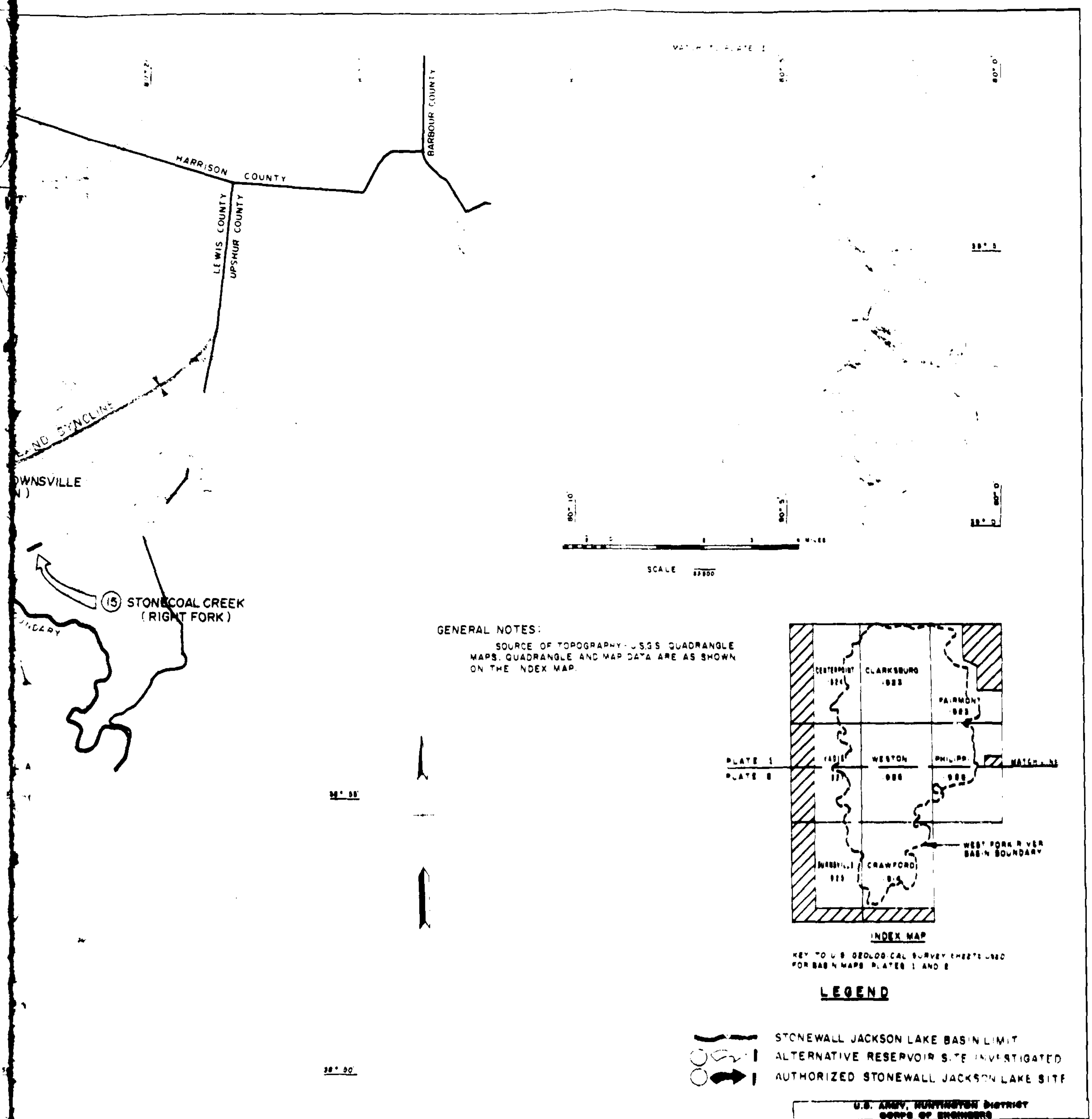
EXHIBIT NO. 6



103
108
TENMILE CREEK (3)
(4)
102
105
106
107
CLARKSBURG
WOLF SUMMIT ANTICLINE
SHINNSTON SYNCLINE
(5) SYCAMORE CREEK
152
HARRISON
LEWIS
COUNTY
COUNTY
(8) KINCHELOE CREEK
SCALE


FAIRMONT
BOOTHS CREEK
2 BINGAMON CREEK
MARION COUNTY
HARRISON COUNTY
108
109
107
4 SIMPSON CREEK
CHESTNUT RIDGE ANTICLINE
BRIDGEPORT
CLARKSBURG
SHINNSTON SYNCLINE
6 ELK CREEK ABOVE BRUSHY FORK
7 BRUSHY FORK OF ELK CREEK
TAYLOR COUNTY
HARRISON COUNTY
BARBOUR COUNTY
PENNSYLVANIA
OHIO
MARYLAND
WEST VIRGINIA
VIRGINIA
PITTSBURGH
WHEELING
MORGANTOWN
FAIRMONT
PARKERSBURG
CLARKSBURG
HUNTINGTON
CHARLESTON
WASHINGTON, D.C.
WEST FORK BASIN
VICINITY MAP
SCALE IN MILES
NOTE
FOR GENERAL NOTES AND LEGEND, SEE PLATE 2 OF BASIN MAP
MATCH TO PLATE 2
SCALE
U.S. ARMY, HUNTINGTON DISTRICT
CORPS OF ENGINEERS
FOUNDATION REPORT
WEST FORK RIVER, WEST VIRGINIA
STONEWALL JACKSON DAM
REGIONAL GEOLOGY
BASIN MAP
NORTHERN SECTION
EXHIBIT NO. 7A


FREEMANS CREEK (9)
HACKERS CREEK (10)
HARRISON COU
LEWIS COUNTY
UPSHUR COUNTY
POLK CREEK (11)
WESTON
GRASSLANDS SYNCLINE
WEST FORK RIVER ABOVE BROWNSVILLE (13)
(12) WEST FORK RIVER AT BROWNSVILLE (STONEWALL JACKSON)
(14) SKIN CREEK
STONEWALL JACKSON BASIN BOUNDARY
(15) STONECOAL CREEK (RIGHT FORK)
(16) SAND FORK
ROANOKE
VANDALIA
ANTICLINE
WEST FORK RIVER ABOVE ARNOLD (17)
ROANOKE SYNCLINE
WALKERVILLE
LEWIS COUNTY
UPSHUR COUNTY
80° 35
80° 30
80° 25
80° 20
38° 50



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FOUNDATION REPORT
WEST FORK RIVER, WEST VIRGINIA
STONEWALL JACKSON DAM

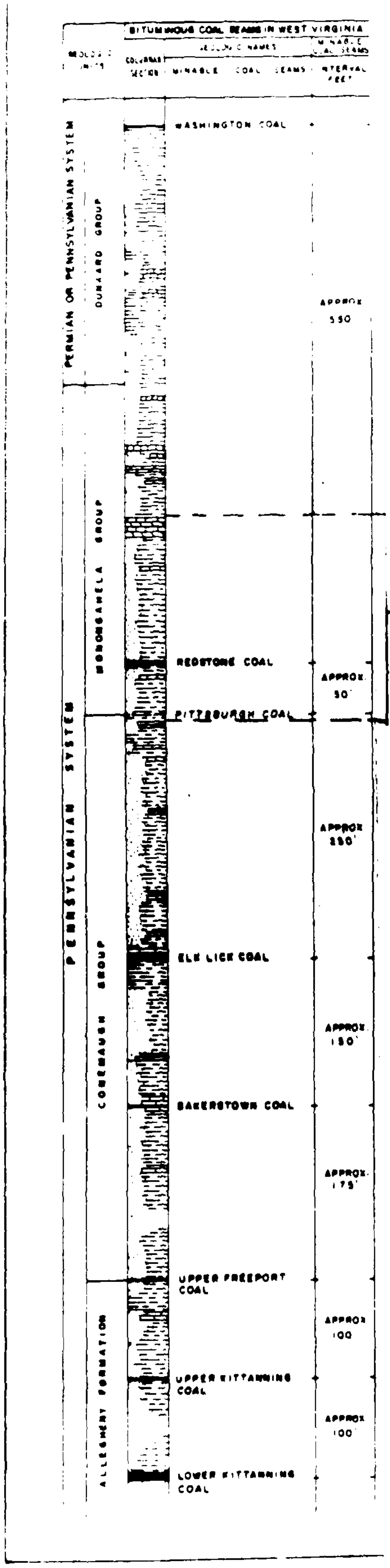
REGIONAL GEOLOGY
BASIN MAP
SOUTHERN SECTION

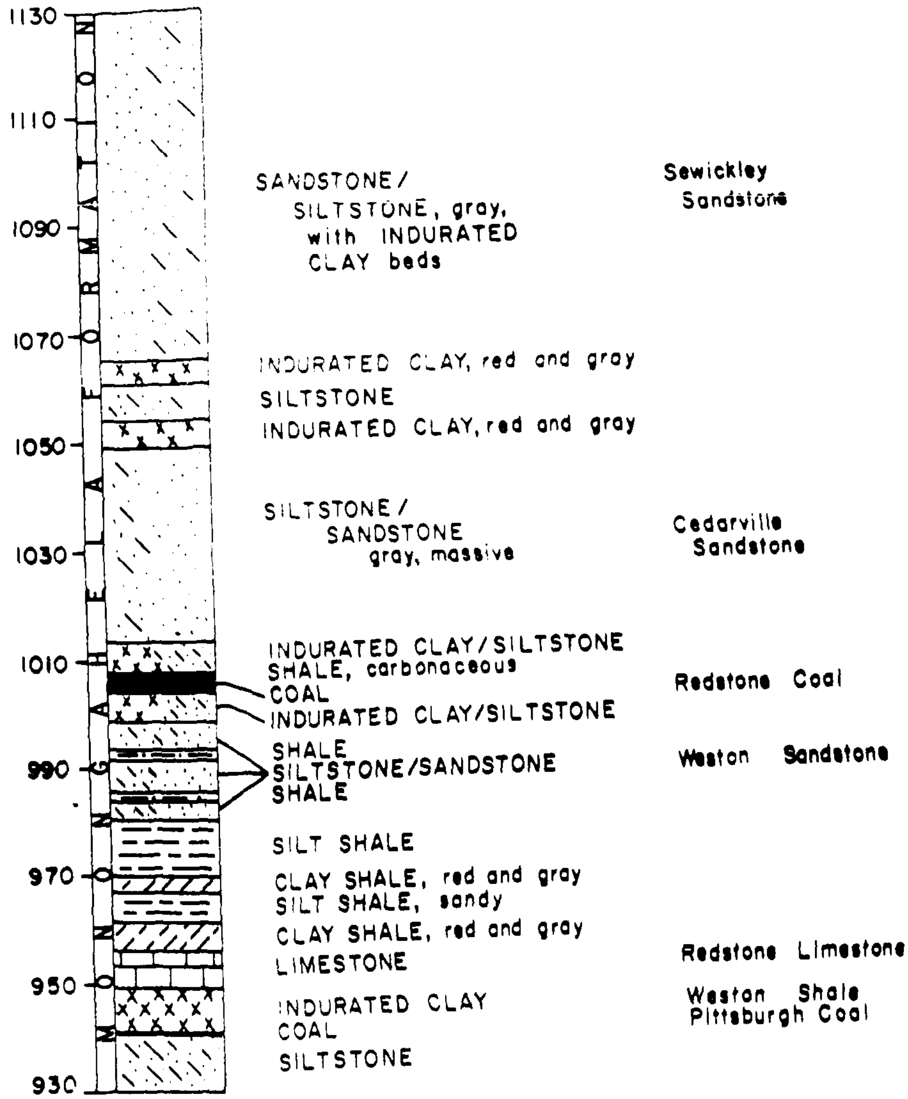
EXHIBIT NO. 7B

STONEWALL JACKSON DAM

WEST FORK RIVER

GENERALIZED GEOLOGIC SECTION





U.S. ARMY, HUNTINGTON DISTRICT
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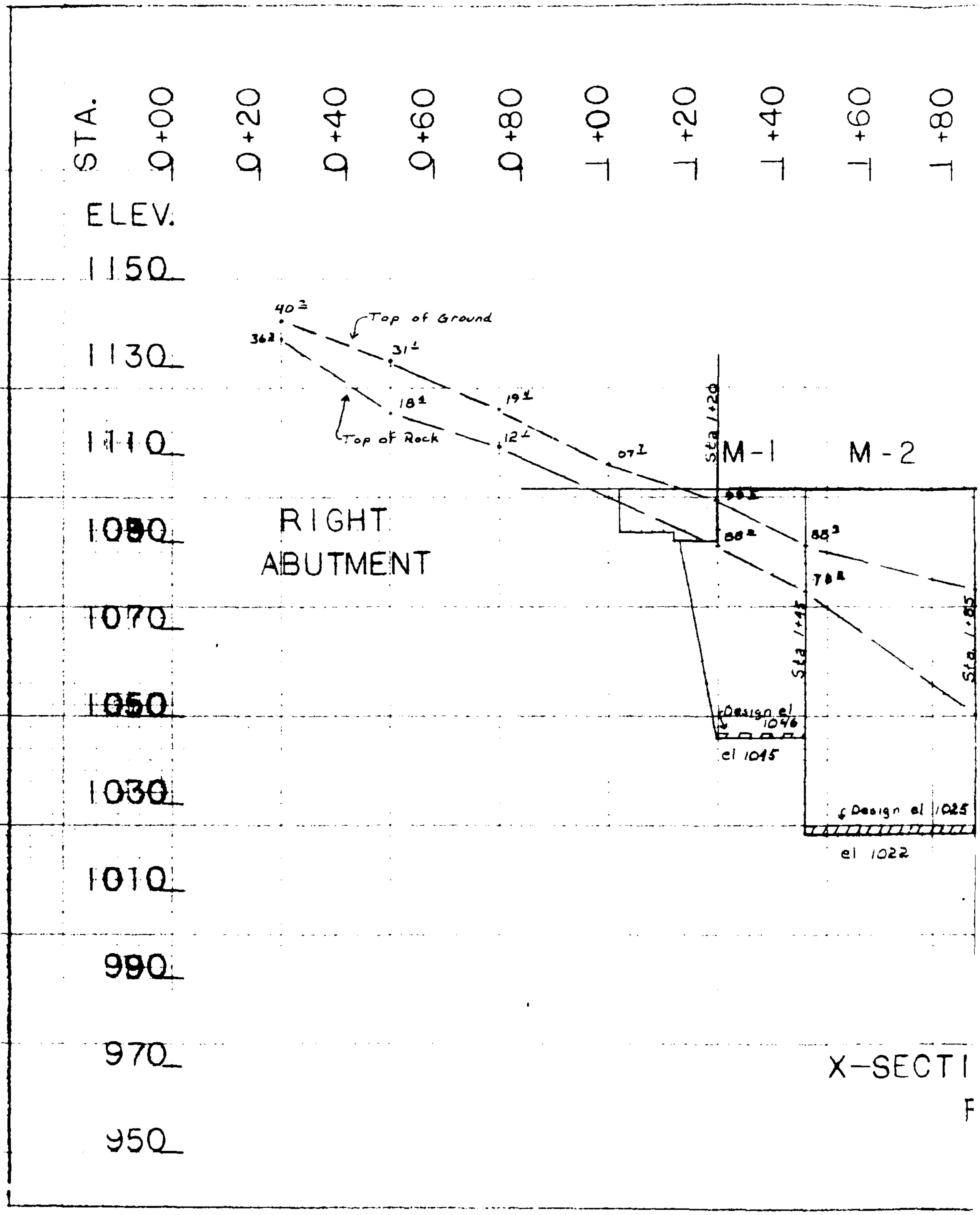
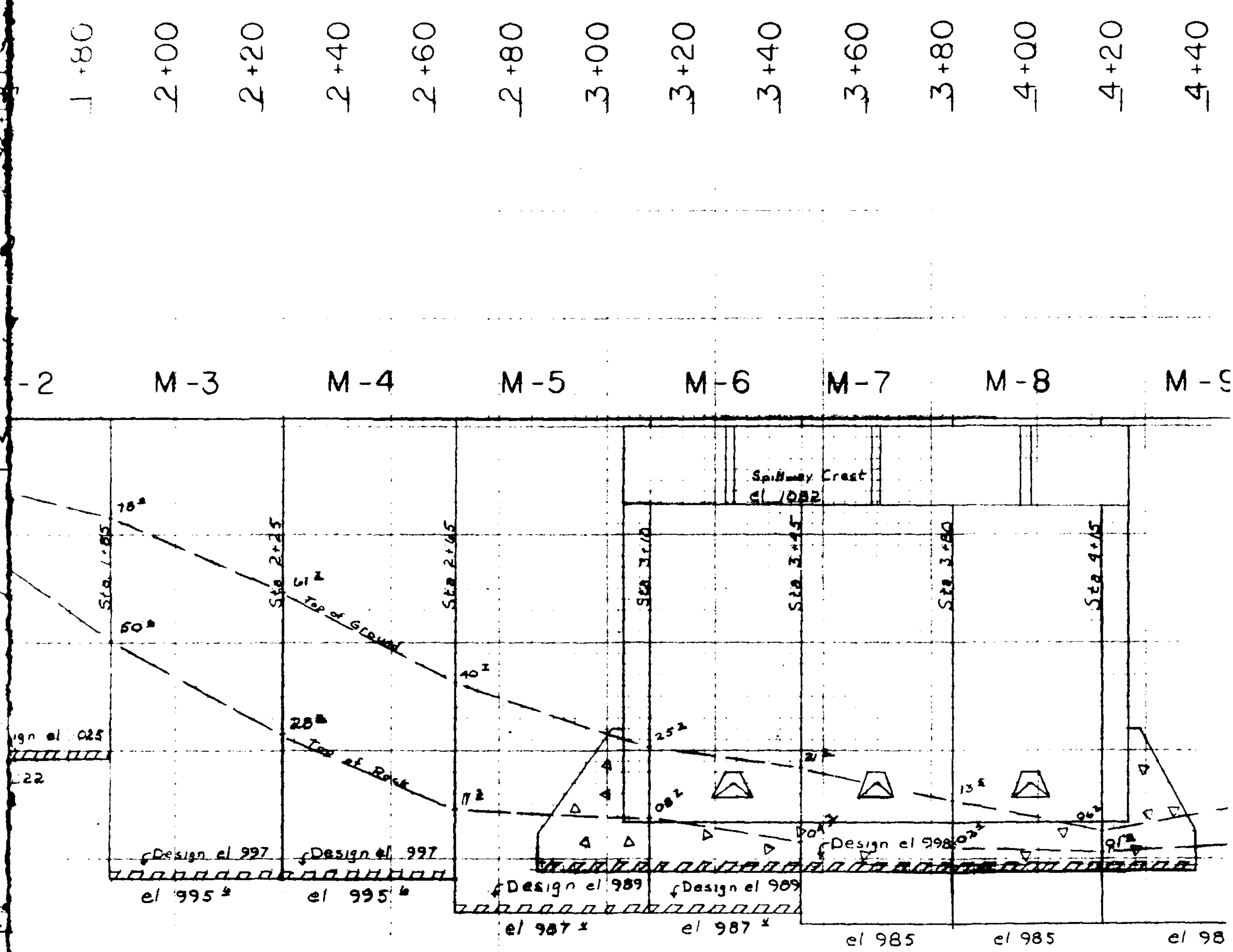
WEST FORK RIVER, WEST VIRGINIA
STONEWALL JACKSON DAM

GEOLOGY SECTION
GENERAL

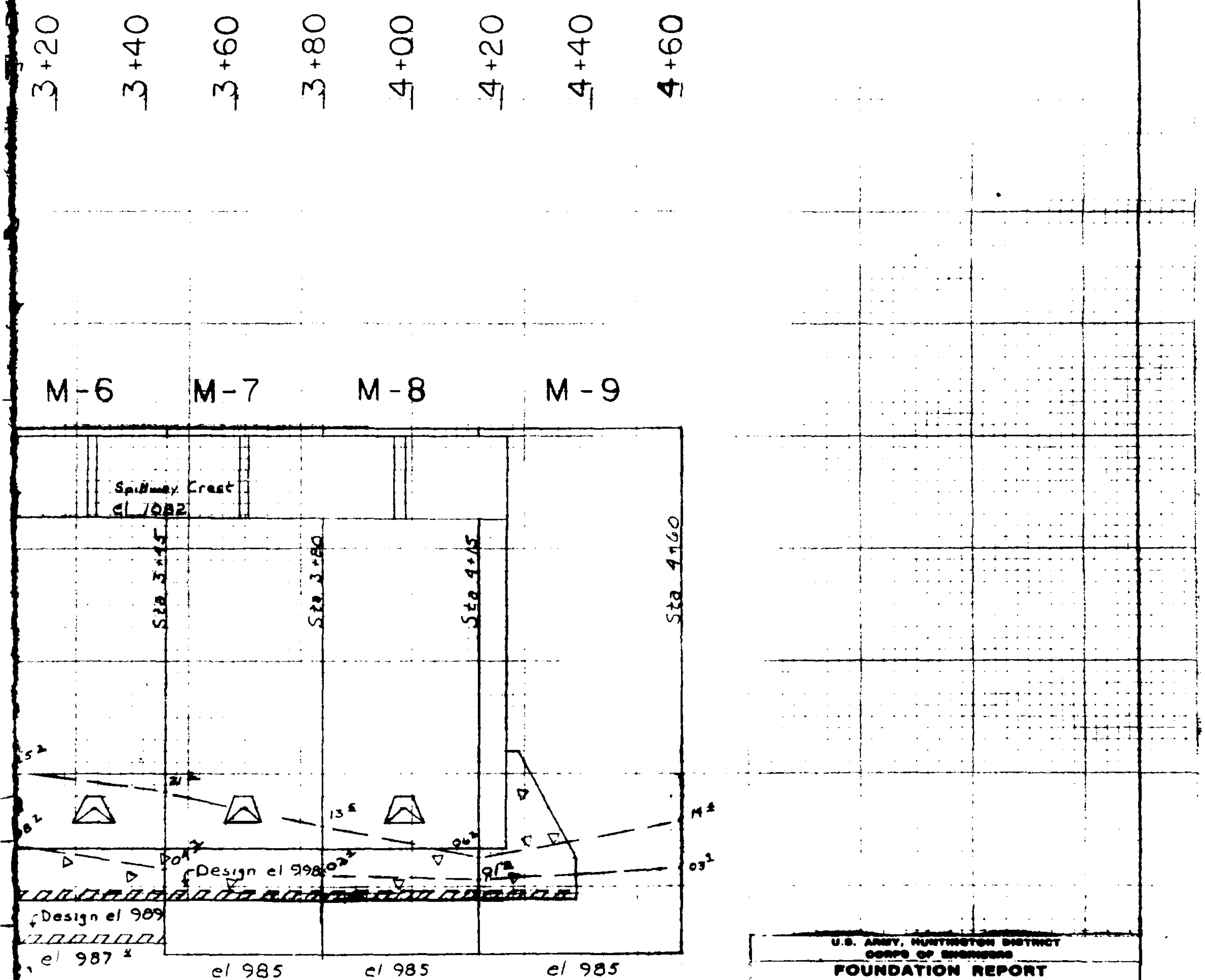
EXHIBIT NO. 8



STA.
0+00
0+20
0+40
0+60
0+80
1+00
1+20
1+40
1+60
1+80
ELEV.
1150
1130
1110
1090
1070
1050
1030
1010
990
970
950
Top of Ground
Top of Rock
RIGHT ABUTMENT
M-1
M-2
Sta 1+20
Sta 1+45
Sta 1+85
Design el 1046
el 1015
Design el 1025
el 1022
X-SECTI
F



SECTION VIEW ALONG DAM AXIS
FACING UPSTREAM



U.S. ARMY, HUNTINGTON DISTRICT
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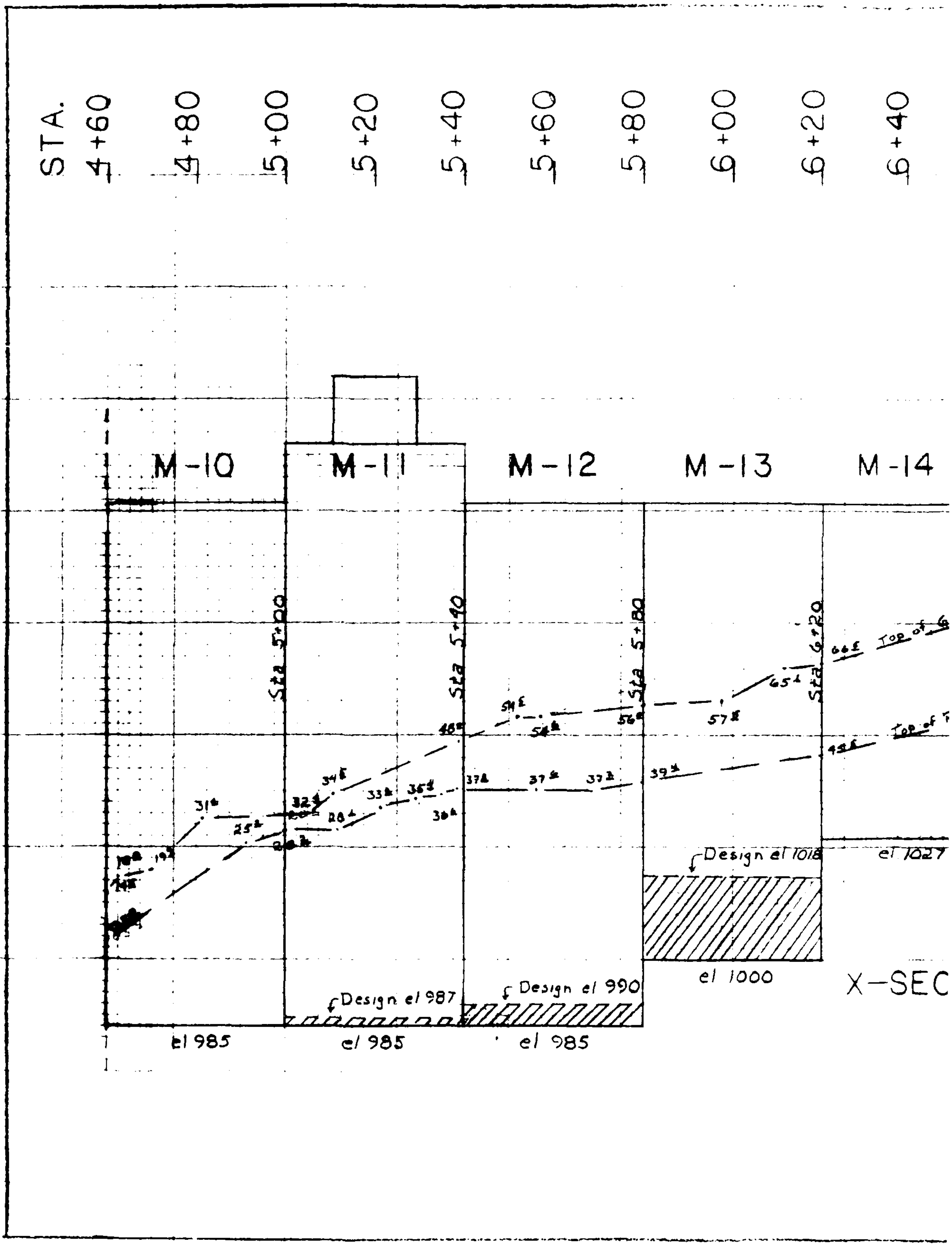
FOUNDATION REPORT
WEST FORK RIVER, WEST VIRGINIA
STONEWALL JACKSON DAM

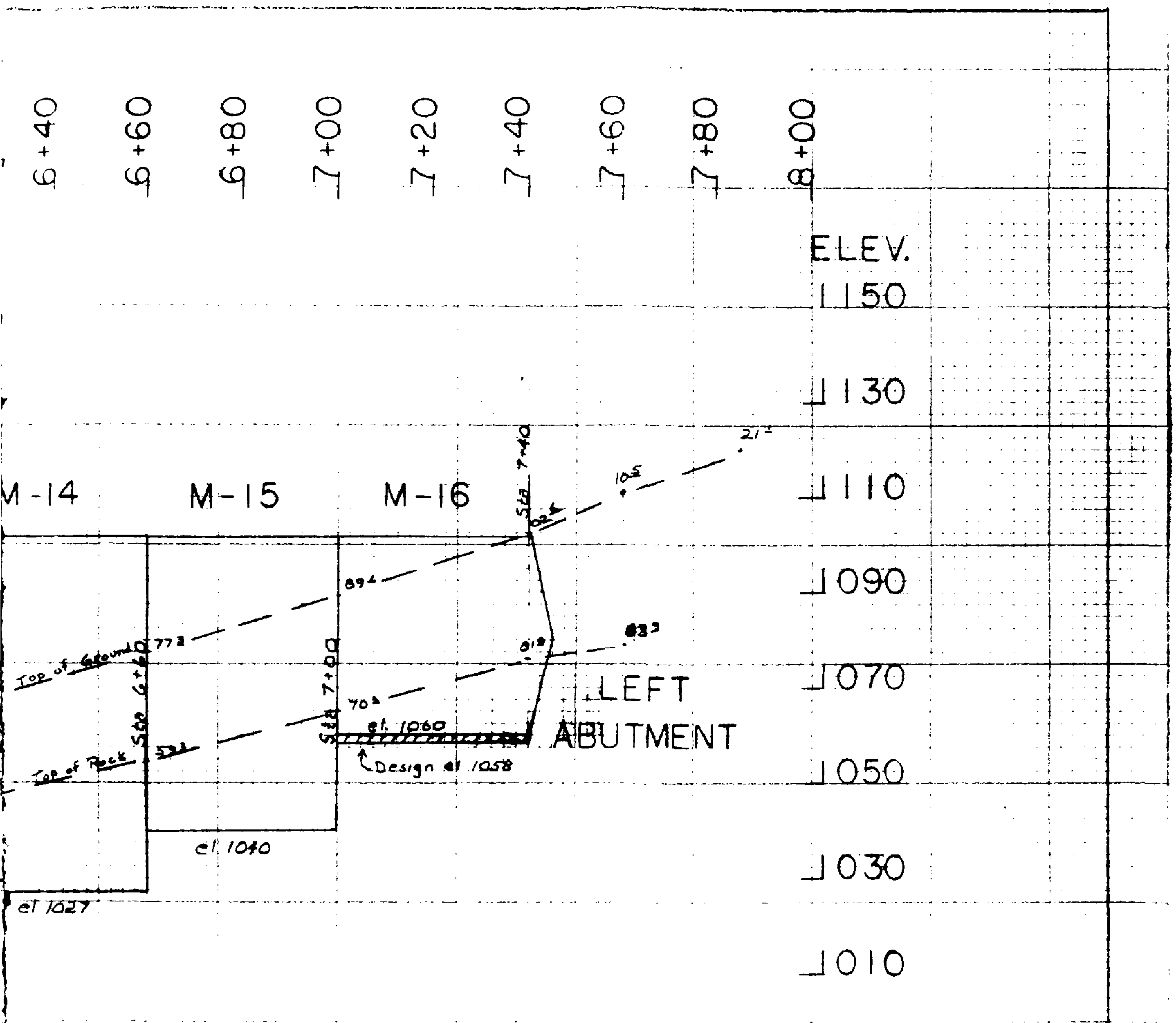
CONCRETE STRUCTURES
FOUNDATIONS
STAGE 1

Scale: 1" = 25'

EXHIBIT NO. 9A



STA. 4+60
4+80
5+00
5+20
5+40
5+60
5+80
6+00
6+20
6+40
M-10
M-11
M-12
M-13
M-14
Sta 5+00
Sta 5+40
Sta 5+80
Sta 6+20
Design el 987
Design el 990
Design el 1018
el 985
el 985
el 985
el 1000
el 1027
X–SEC



SECTION VIEW ALONG DAM AXIS
FACING UPSTREAM

U.S. ARMY, HUNTINGTON DISTRICT
CORPS OF ENGINEERS
FOUNDATION REPORT
WEST FORK RIVER, WEST VIRGINIA
STONEWALL JACKSON DAM

CONCRETE STRUCTURES
FOUNDATIONS
STAGE 2

Scale: 1" = 20'

EXHIBIT NO. 9B

EXHIBIT NO. 9

CONCRETE STRUCTURES FOUNDATION

(INDIVIDUAL MONOLITHS)

Exhibit No.		Subject
9-1A	Mono. 1	Statistical Data
9-1B	Mono. 1	Exploratory, Instrumentation, Photos
9-1C	Mono. 1	Foundation Geology
9-2A	Mono. 2	Statistical Data
9-2B	Mono. 2	Exploratory, Instrumentation, Photos
9-2C	Mono. 2	Foundation Geology
9-3A	Mono. 3	Statistical Data
9-3B	Mono. 3	Exploratory, Instrumentation, Photos
9-3C	Mono. 3	Foundation Geology
9-4A	Mono. 4	Statistical Data
9-4B	Mono. 4	Exploratory, Instrumentation, Photos
9-4C	Mono. 4	Foundation Geology
9-5A	Mono. 5	Statistical Data
9-5B	Mono. 5	Exploratory, Instrumentation, Photos
9-5C	Mono. 5	Foundation Geology
9-6A	Mono. 6	Statistical Data
9-6B	Mono. 6	Exploratory, Instrumentation, Photos
9-6C	Mono. 6	Foundation Geology
9-7A	Mono. 7	Statistical Data
9-7B	Mono. 7	Exploratory, Instrumentation, Photos

9-7C	Mono. 7	Foundation Geology
9-8A	Mono. 8	Statistical Data
9-8B	Mono. 8	Exploratory, Instrumentation, Photos
9-8C	Mono. 8	Foundation Geology
9-9A	Mono. 9	Statistical Data
9-9B	Mono. 9	Exploratory, Instrumentation, Photos
9-9C	Mono. 9	Foundation Geology
9-10A	Mono. 10	Statistical Data
9-10B	Mono. 10	Exploratory, Instrumentation, Photos
9-10C	Mono. 10	Foundation Geology
9-11A	Mono. 11	Statistical Data
9-11B	Mono. 11	Exploratory, Instrumentation, Photos
9-11C	Mono. 11	Foundation Geology
9-12A	Mono. 12	Statistical Data
9-12A1	Mono. 12	Dewatering Plan
9-12A2	Mono. 12	Dewatering Plan
9-12A3	Mono. 12	Dewatering Plan
9-12B	Mono. 12	Exploratory, Instrumentation, Photos
9-12C	Mono. 12	Foundation Geology
9-13A	Mono. 13	Statistical Data
9-13B	Mono. 13	Exploratory, Instrumentation, Photos
9-13C	Mono. 13	Foundation Geology
9-14A	Mono. 14	Statistical Data
9-14B	Mono. 14	Exploratory, Instrumentation, Photos
9-14C	Mono. 14	Foundation Geology
9-15A	Mono. 15	Statistical Data
9-15B	Mono. 15	Exploratory, Instrumentation, Photos

9-15C	Mono. 15	Foundation Geology
9-16A	Mono. 16	Statistical Data
9-16B	Mono. 16	Exploratory, Instrumentation, Photos
9-16C	Mono. 16	Foundation Geology
9-17A	Mono. 17,18,19	Right Training Wall
9-17B	Mono. 17,18,19	Exploratory, Instrumentation, Photos
9-17C	Mono. 17,18,19	Foundation Geology
9-18A	Mono. 20 21 22	Left Training Wall
9-18B	Mono. 20,21,22	Exploratory, Instrumentation, Photos
9-18C	Mono. 20,21,22	Foundation Geology
9-19A	Stilling Basin	Statistical Data
9-19B	Stilling Basin	Exploratory, Instrumentation, Photos
9-19C	Stilling Basin	Foundation Geology

FOUNDATION GEOLOGY

MONOLITH NO. 1

LOCATION: Dam Monolith STATION: 1+20 to 1+45

REFERENCE EXPLORATORY BORINGS:

(1) Pre-contract: 65

(2) During Contract: 217

FOUNDATION:

(1) Elevation: 1045

(2) Dimensions: Width 25'-0"; Length 41'-1 11/16"

(3) Description: Sandstone; silty, fine grained, moderately hard

(4) Special or Unusual Conditions: Several open to high angle, weathered joints transversing foundation floor

(5) Treatment: Standard final clean-up; fill open joints by brush grouting prior to placing concrete

(6) Dewatering: Standard small sump pumps used during concrete placement

(7) Instrumentation: None

(8) Photographs: 111 to 125
(See Volume II of this report)

(9) First Placement: 17 October 198[illegible]

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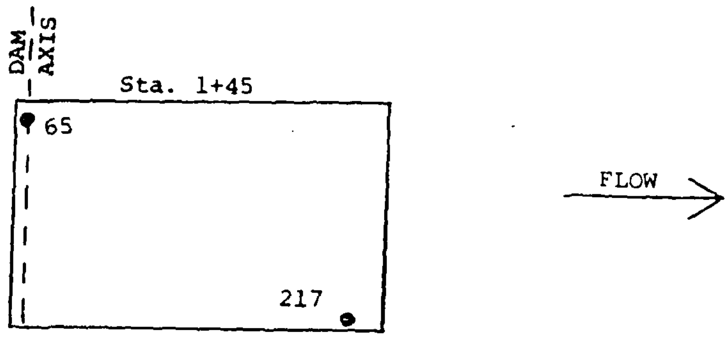
STATISTICAL DATA
MONOLITH - 1

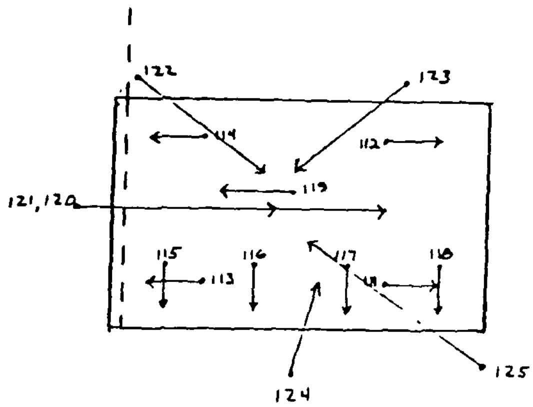
EXHIBIT NO. 9-1A

MONOLITH I

FOUNDING ELEV. 1045



EXPLORATORY BORINGS



PHOTOGRAPHS

U.S. ARMY, HUNTINGTON DISTRICT
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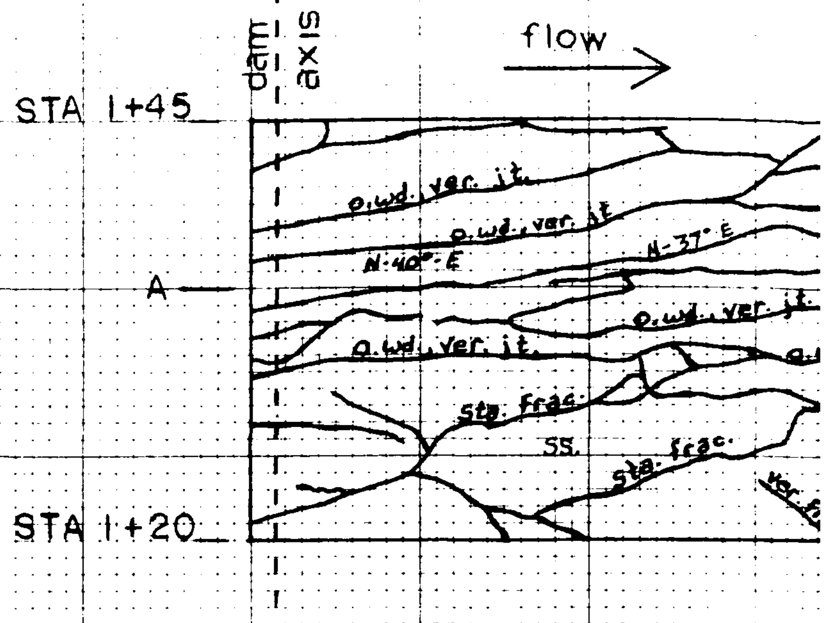
FOUNDATION REPORT
WEST FORK RIVER, WEST VIRGINIA
STONEWALL JACKSON DAM

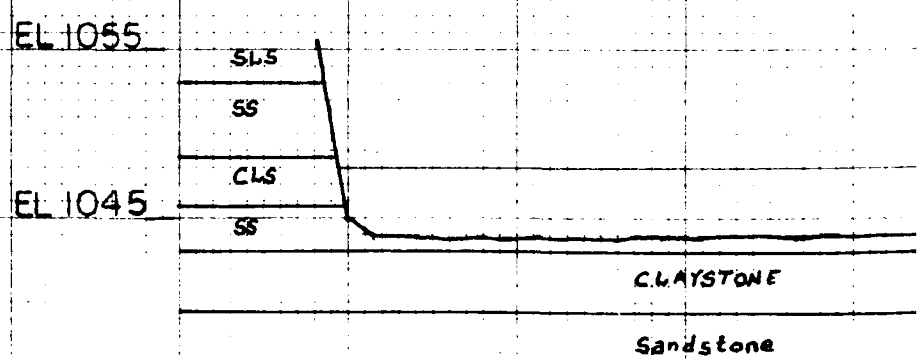
EXPLORATORY BORINGS
INSTRUMENTATION
PHOTOGRAPHS

Scale: 1" = 20' PLAN VIEW

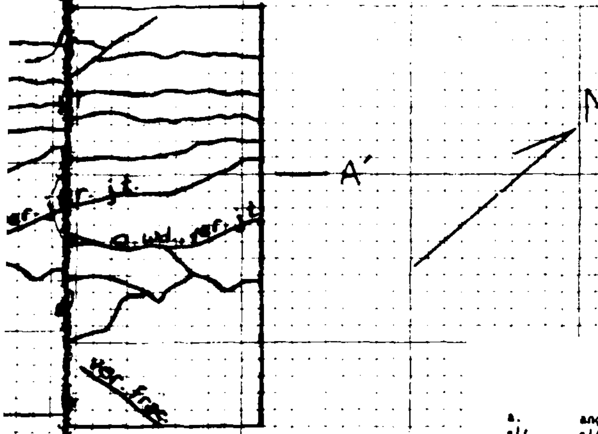
EXHIBIT NO. 9-18



PLAN VIEW

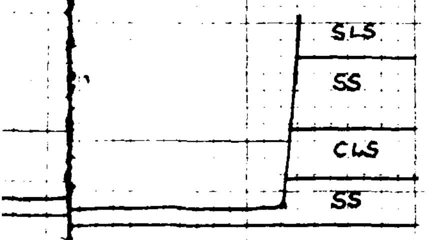


X — SECTION
A — A′



ABBREVIATIONS

a.	angle
alt.	alternat(e)(ly)(ing)
amt.	amount
ang.	angular
approx.	approximate(ly)
ar.	argillaceous
aren.	arenaceous
asp.	asphaltic
b.	bone
ba.	banded(ing)
bd.	bed(ded)(ing)
bdr.	bedrock
bf.	buff
bk.	black
bky.	blocky
bkn.	broken
bl.	blue
bou.	boulder(s)
bre.	breccia(ted)
br.	brown
c.	coarse
ca.	calcareous
carb.	carbonaceous
cav.	cavern, cavity
cbl.	cobble(y)
ch.	chert
cl.	clayey
cle.	clean
coa.	coated(ing)
comp.	compact
conc.	concretion
cong.	conglomeratic
cont.	contains
cr.	crushed
crm.	crumbly
cst.	crystal(line)
cem.	cement(ed)
di.	dirty
dia.	diameter
diag.	diagonal
dis.	disintegrated
disc.	discontinuous
diss.	disseminated
dk.	dark
dn.	dense
dmp.	damp
ext.	extremely
f.	fine
fer.	ferruginous
fis.	fissile
fil.	filled(ing)
fos.	fossil(iferous)
frac.	fracture(d)
frags.	fragment(s)(al)
fri.	friable
f.w.	free water
g.	grain(ed)
gen.	generally
gn.	green
gr.	gray
gra.	gravelly
grad.	grading(ed)
G.W.	ground water
h.	hard
ha.	high angle
hi.	high(ly)(er)
hor.	horizontal(ly)
inc.	inclusions
incr.	increasing(ly)
inla.	interlaminated
intbd.	interbedded
irr.	irregular
jt.	joint(ed)
l.	little
la.	low angle
las.	laminat(ions)(ed)
lay.	layer(s)
le.	lean
lea.	leached
len.	lense(s)
lg.	large
lt.	light
m.	moderate(ly)
ma.	many
mas.	massive(ly)
mat.	material
mic.	micaceous
mla.	mineralized
mos.	mostly
mot.	mottled
mst.	moist
mtx.	matrix
n.	near
nod.	nodule(s)
num.	numerous
o.	open
occ.	occasional(ly)
occu.	occurring
org.	organic
pa.	parting(s)
part.	particle(s)
pl.	plastic
peb.	pebble(s)
pk.	pink
pkt.	pocket(s)
pit.	pit(ted)
pn.	plane(s)
po.	porous
pt.	part(ly)
pyr.	pyrite(ic)
q.	quartzitic
r.	red
ro.	rock(s)
rot.	rotten(ed)
rou.	round(ed)
rt.	root(s)(let)
s.	soft
sa.	sandy
sat.	saturated
scat.	scattered
se.	seams
sev.	severely
sevr.	several
sh.	shaly
sil.	siliceous
sl.	silty
sli.	slight(ly)
slk.	slickensided
sm.	small
so.	some
sol.	solution
sta.	stain(ed)
stf.	stiff
stks.	streak(s)
str.	stringer(s)
sty.	stylolite(ic)
t.	thin
tho.	throughout
tk.	thick
tr.	trace
v.	variably
va.	variegated
ve.	very
veg.	vegetation
ver.	vertical(ly)
vu.	vuggy
w.	water
/	with
w.c.	water content
wd.	weathered
whi.	white
x-bd.	cross bedded(ing)
y.	yellow
zo.	zone



U.S. ARMY, HUNTINGTON DISTRICT
CORPS OF ENGINEERS

FOUNDATION REPORT
WEST FORK RIVER, WEST VIRGINIA
STONEWALL JACKSON DAM

FOUNDATION GEOLOGY
MONOLITH - 1

Scale: 1" = 20' PLAN VIEW

EXHIBIT NO. 9-1C

FOUNDATION GEOLOGY

MONOLITH NO. 2

LOCATION: Dam Monolith STATION: 1+45 to 1+85

REFERENCE EXPLORATORY BORINGS:
(1) Pre-contract: 74

(2) During Contract: 200,216

FOUDATION:
(1) Elevation: 1022

(2) Dimenstions: Width 40' 0"; Length 59' 3-5/8"

(3) Description: Between Sta. 1+45 and 1+65, near horizontal silty sandstone: Between Sta. 1+65 and 1+85, thin to medium bedded silty sandstones and and siltstones dipping approximately 22 degrees toward the east

(4) Special or Unusual Conditions: N 45 degrees E, normal fault line with a 50 degree NW dip runs lengthwise near center of monolith floor: Several open, high angle, fault related joints between Sta. 1+65 and 1+85

(5) Treatment: 12 cubic yards dental concrete placed 09 Aug 1984 to correct overbrake at Monolith 2/3 face: After final clean-up of foundation, 4 cubic yards of heavy grout was burshed into the fault line and associated open joints

(6) Dewatering: Standard small sump pumps used during concrete placement.

(7) Instrumentation: None

(8) Photographs: 97 to 107
(See Volume II of this report)

(9) First Placement: 06 September 1984

U.S. ARMY, HUNTINGTON DISTRICT
CORPS OF ENGINEERS

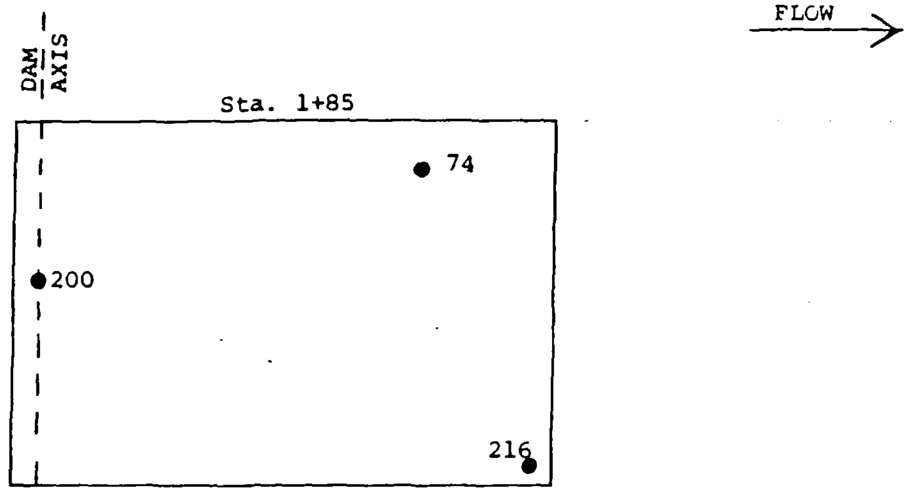
FOUNDATION REPORT
WEST FORK RIVER, WEST VIRGINIA
STONEWALL JACKSON DAM

STATISTICAL DATA
MONOLITH - 2

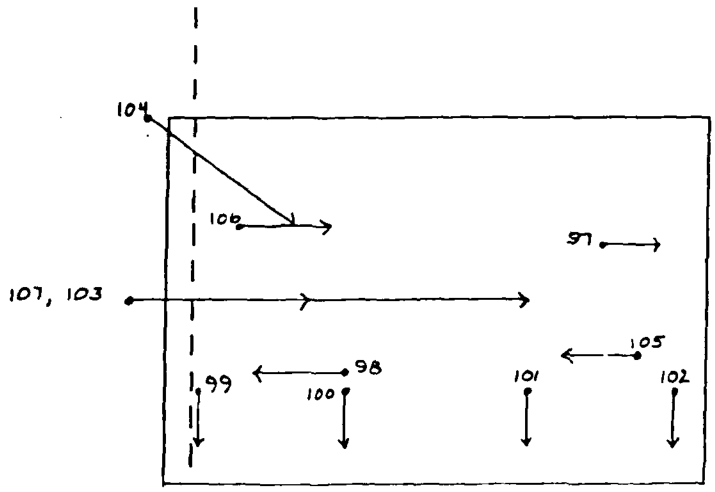
EXHIBIT NO. 9-2A

MONOLITH 2

FOUNDING ELEV. 1022



EXPLORATORY BORINGS



PHOTOGRAPHS

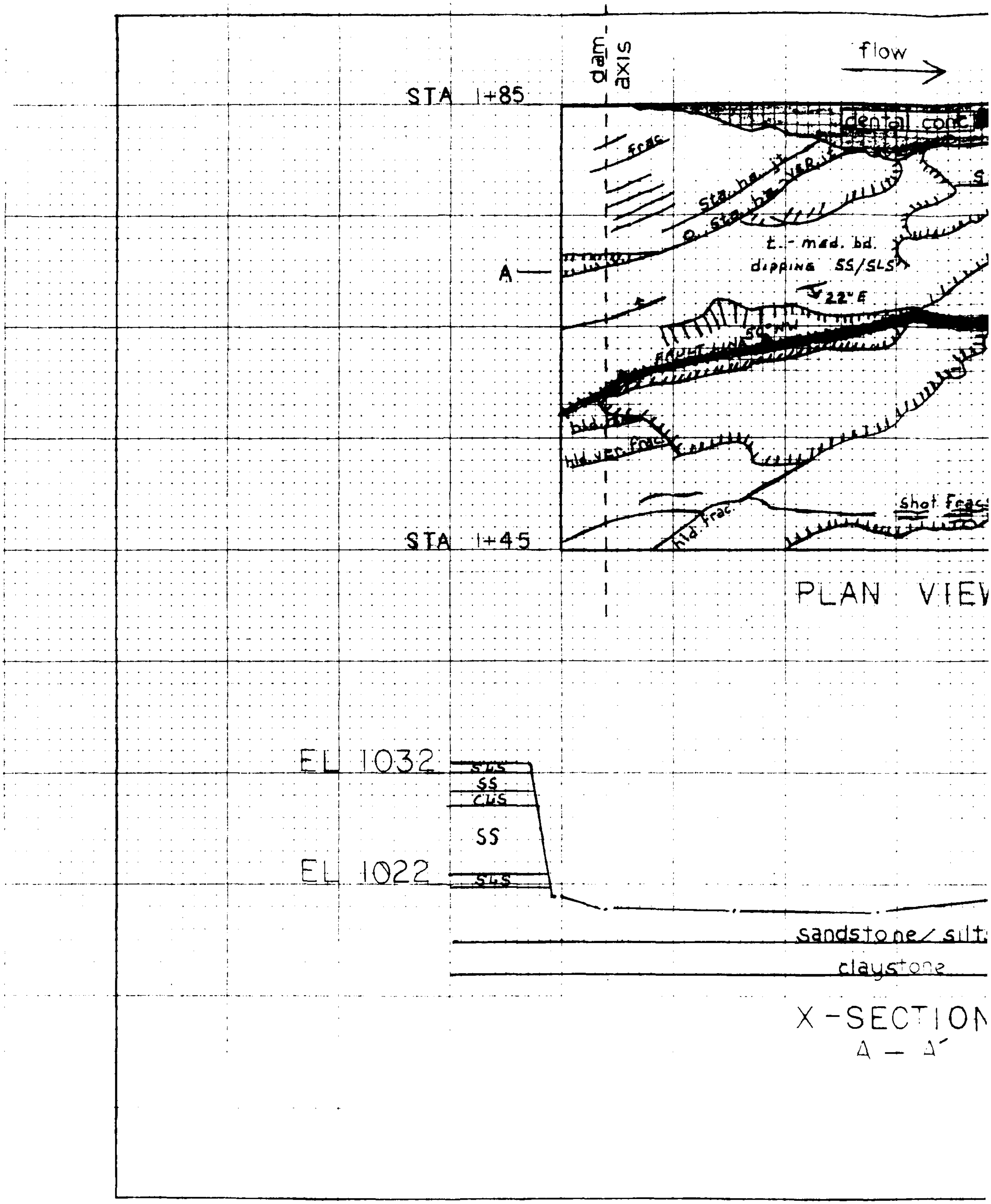
U.S. ARMY, HUNTINGTON DISTRICT
CORPS OF ENGINEERS

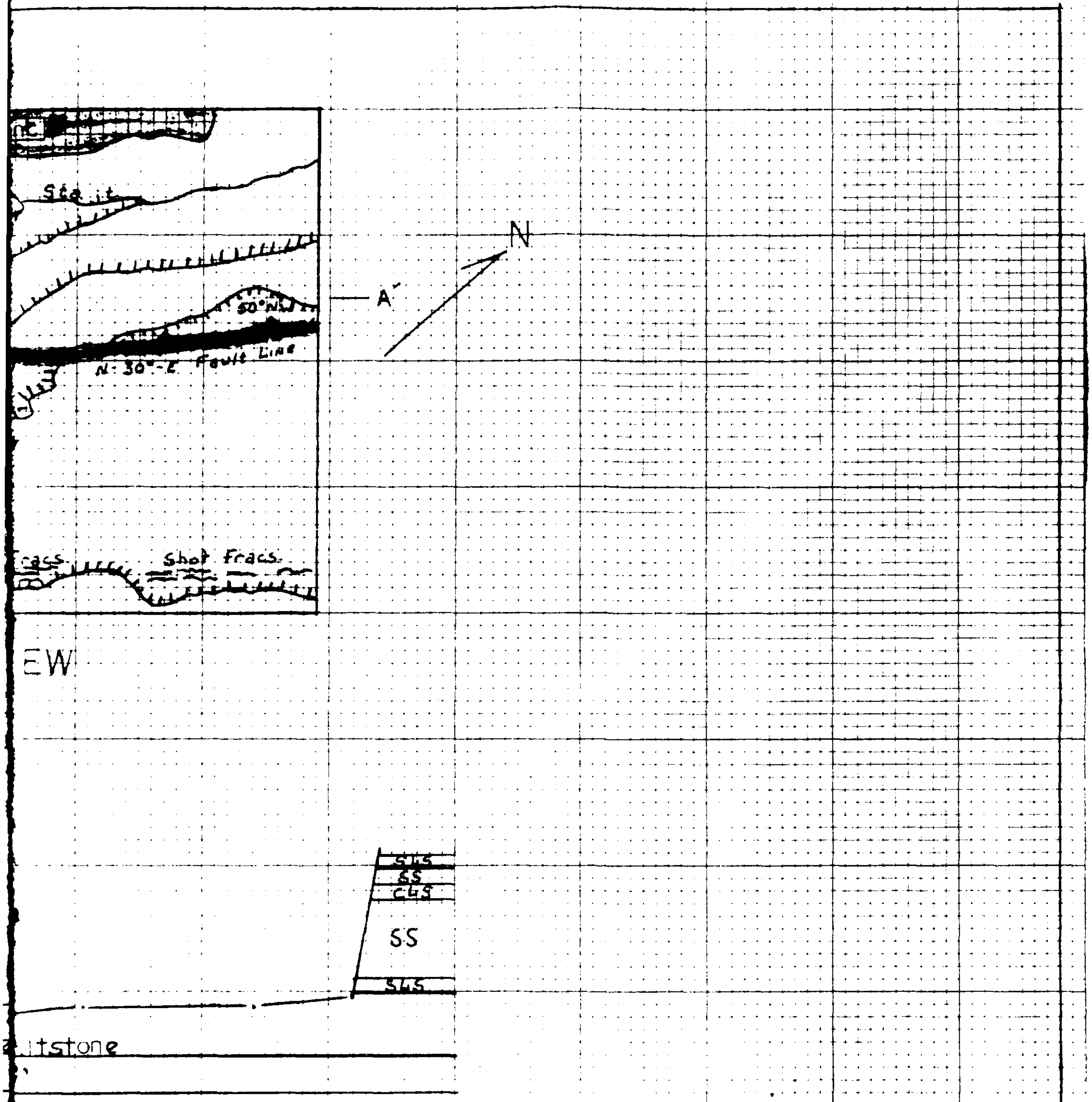
FOUNDATION REPORT
WEST FORK RIVER, WEST VIRGINIA
STONEWALL JACKSON DAM

EXPLORATORY BORINGS
INSTRUMENTATION
PHOTOGRAPHS

Scale: 1" = 20'   PLAN VIEW

EXHIBIT NO. 9-2B


dam axis
flow
STA 1+85
dental conc.
frac.
A
t.- med. bd.
dipping SS/SLS
22° E
hld ver. frac.
hld. frac.
shot fracs
STA 1+45
PLAN VIEW
EL 1032
SLS
SS
CLS
SS
EL 1022
SLS
sandstone/silt
claystone
X-SECTION
A — A'



U.S. ARMY, HUNTINGTON DISTRICT
CORPS OF ENGINEERS

FOUNDATION REPORT
WEST FORK RIVER, WEST VIRGINIA
STONEWALL JACKSON DAM

FOUNDATION GEOLOGY
MONOLITH - 2

Scale: 1" = 10' PLAN VIEW

EXHIBIT NO. 9-2C

10-02

FOUNDATION GEOLOGY

MONOLITH NO. 3

LOCATION: Dam Monolith STATION: 1+85 to 2+25

REFERENCE EXPLORATORY BORINGS:
(1) Pre-contract: 14, 73A

(2) During Contract: 215

FOUNDATION:
(1) Elevation: 995.6

(2) Dimensions: Width 40' 0"; Length 80' 1-15/16"

(3) Description: Near horizontal, silty, fine grained sandstone

(4) Special or Unusual Conditions: Few thin (1/4"-1/2") dark shale filled, vertical joints

(5) Treatment: Standard final clean-up with special care in cleaning exposed Redstone coal seam along foundation wall

(6) Dewatering: Standard small sump pumps used during concrete placement

(7) Instrumentation: None

(8) Photographs: 64 to 71
(See Volume II of this report)

(9) First Placement: 03 July 1984

U.S. ARMY, HUNTINGTON DISTRICT
CORPS OF ENGINEERS

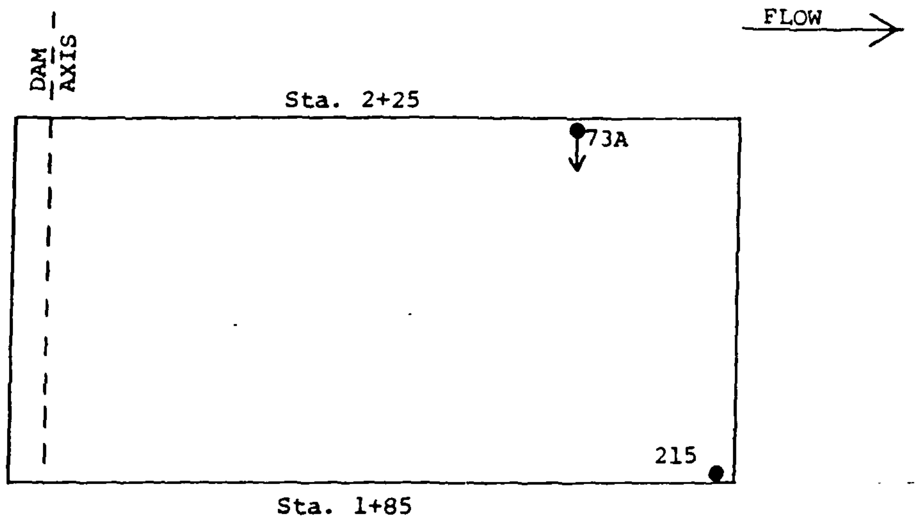
FOUNDATION REPORT
WEST FORK RIVER, WEST VIRGINIA
STONEWALL JACKSON DAM

STATISTICAL DATA
MONOLITH - 3

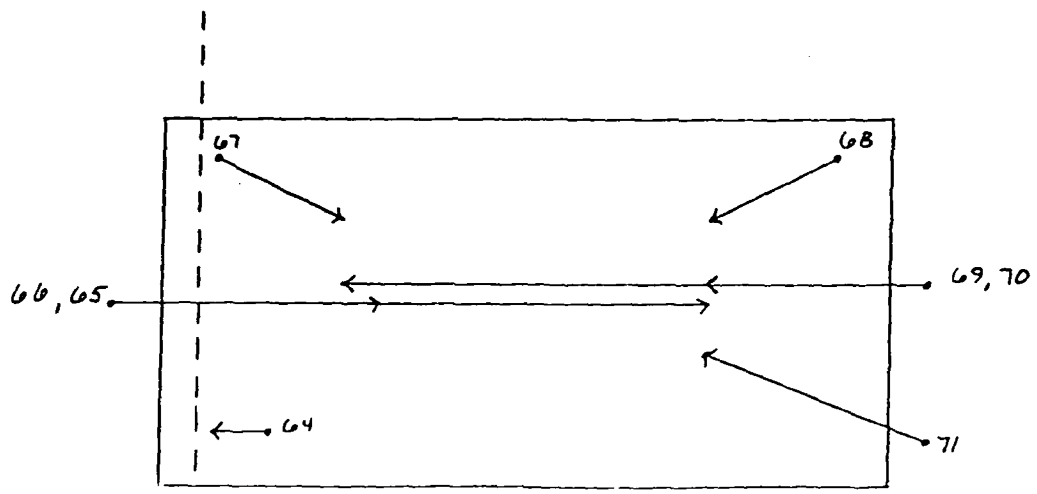
EXHIBIT NO. 9-3A

MONOLITH 3

FOUNDING ELEV. 995.6



EXPLORATORY BORINGS



PHOTOGRAPHS

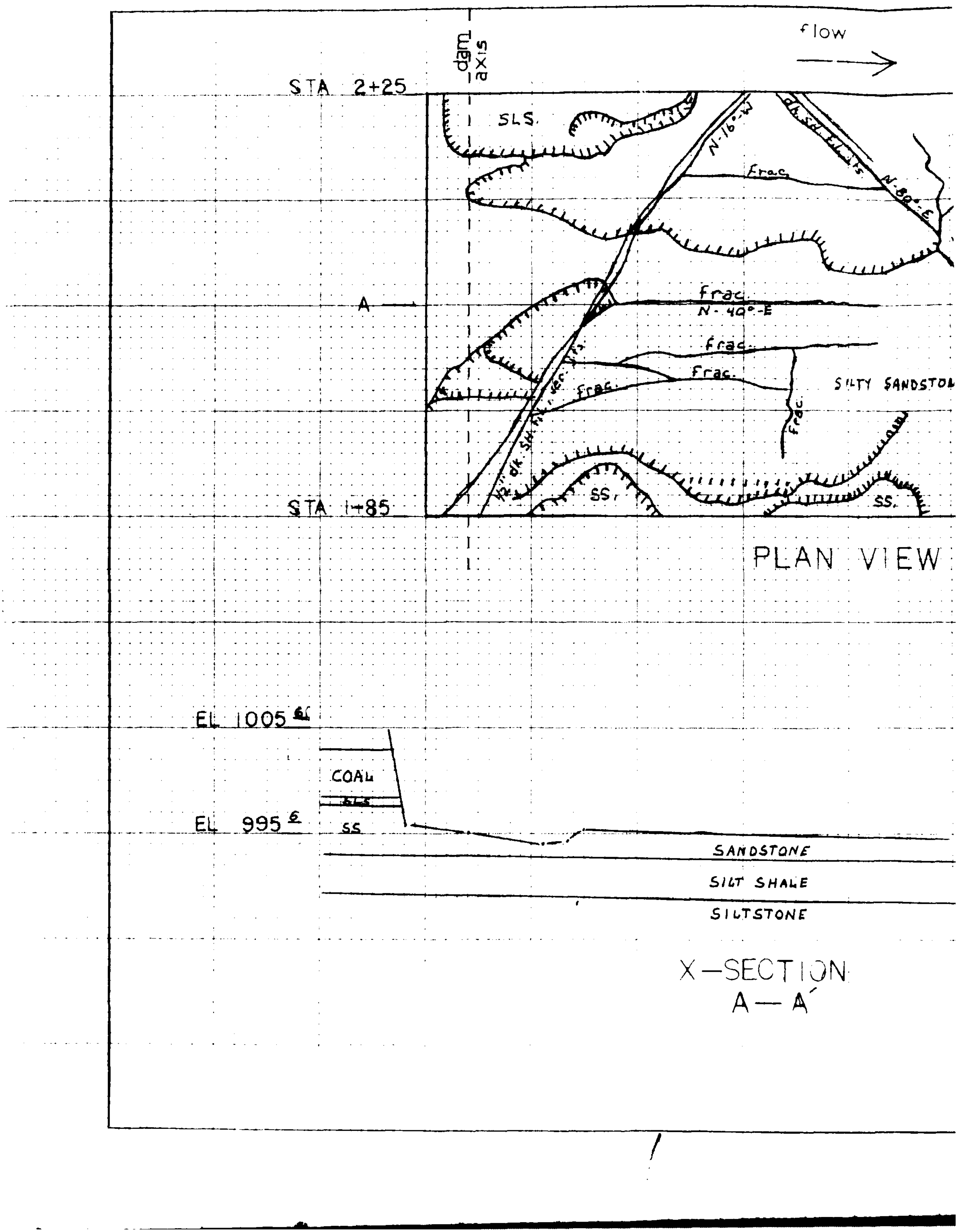
U.S. ARMY, HUNTINGTON DISTRICT
CORPS OF ENGINEERS

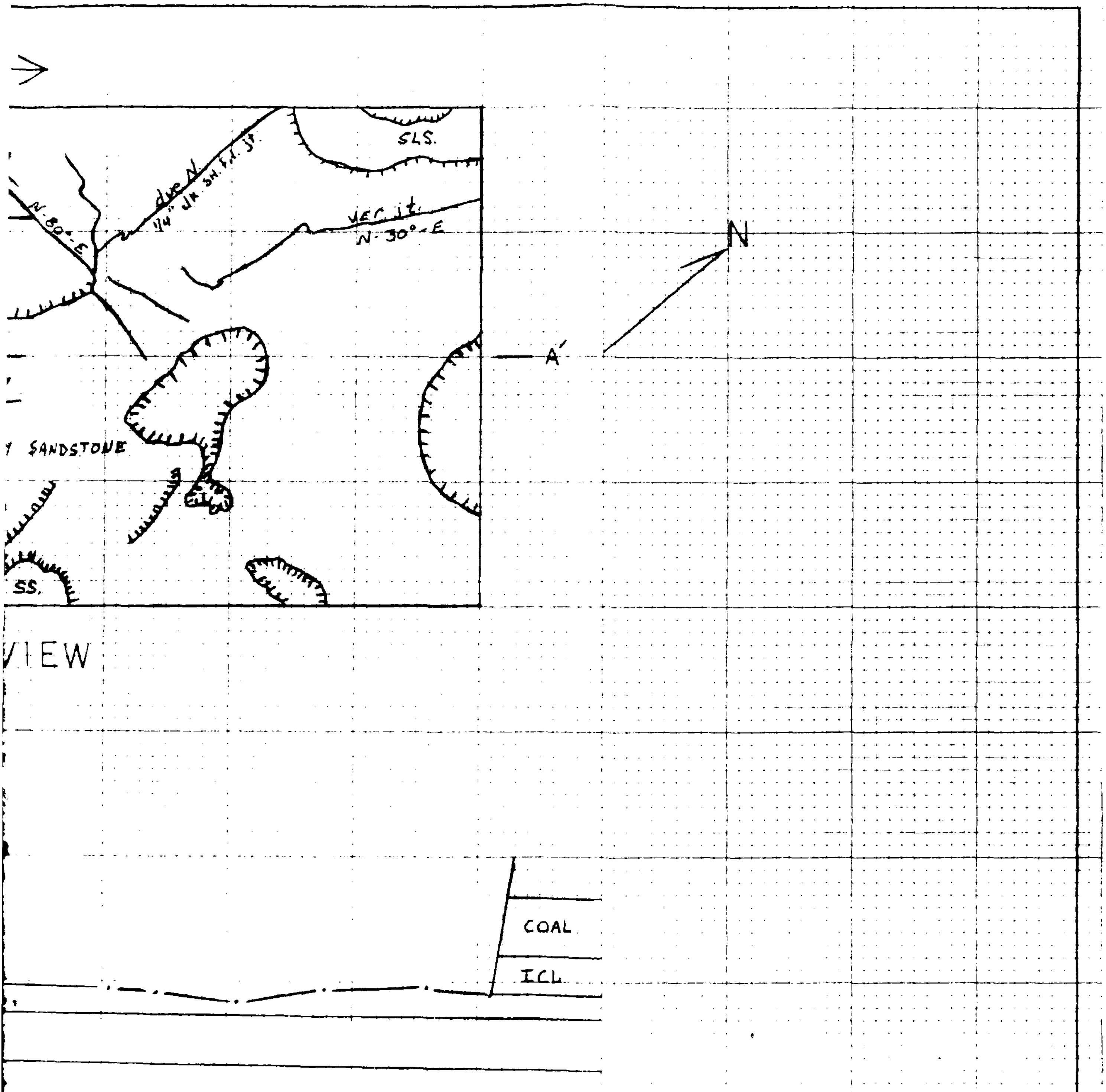
FOUNDATION REPORT
WEST FORK RIVER, WEST VIRGINIA
STONEWALL JACKSON DAM

EXPLORATORY BORINGS
INSTRUMENTATION
PHOTOGRAPHS

Scale: 1" = 20'   PLAN VIEW

EXHIBIT NO. 9-3B


flow
dam axis
STA 2+25
SLS.
N-16°-W
dk. sh. fill. 1's
N-80°-E
Frac.
A
Frac.
N-40°-E
Frac.
Frac.
Frac.
SILTY SANDSTON
Frac.
SS.
SS.
STA 1+85
PLAN VIEW
EL 1005
COAL
SLS
EL 995
SS
SANDSTONE
SILT SHALE
SILTSTONE
X—SECTION
A—A´



U.S. ARMY, HUNTINGTON DISTRICT
CORPS OF ENGINEERS

FOUNDATION REPORT
WEST FORK RIVER, WEST VIRGINIA
STONEWALL JACKSON DAM

FOUNDATION GEOLOGY
MONOLITH - 3

Scale: 1" = 10'   PLAN VIEW

EXHIBIT NO. 9-3C

FOUNDATION GEOLOGY

MONOLITH NO. 4

LOCATION: Dam Monolith STATION: 2+25 to 2+65

REFERENCE EXPLORATORY BORINGS:
(1) Pre-contract: 73A, 93

(2) During Contract: 214

FOUNDATION:
(1) Elevation: 995.6

(2) Dimensions: Width 40′ 0"; Length 80′ 1-15/16"

(3) Description: Near horizontal, sandy siltstone with cherty nodules/fine grained, silty sandstone

(4) Special or Unusual Conditions: Since this monolith was used for Stage 2 diversion, excavation was extended downstream of monoltih's limits to obtain "toe-in" into base of right abutment. Few dark shale filled, vertical joints in foundation

(5) Treatment: Standard final clean-up

(6) Dewatering: Standard small sump pumps

(7) Instrumentation: None

(8) Photographs: 93 to 96
(See Volume II of this report)

(9) First Placement: 16 August 1984

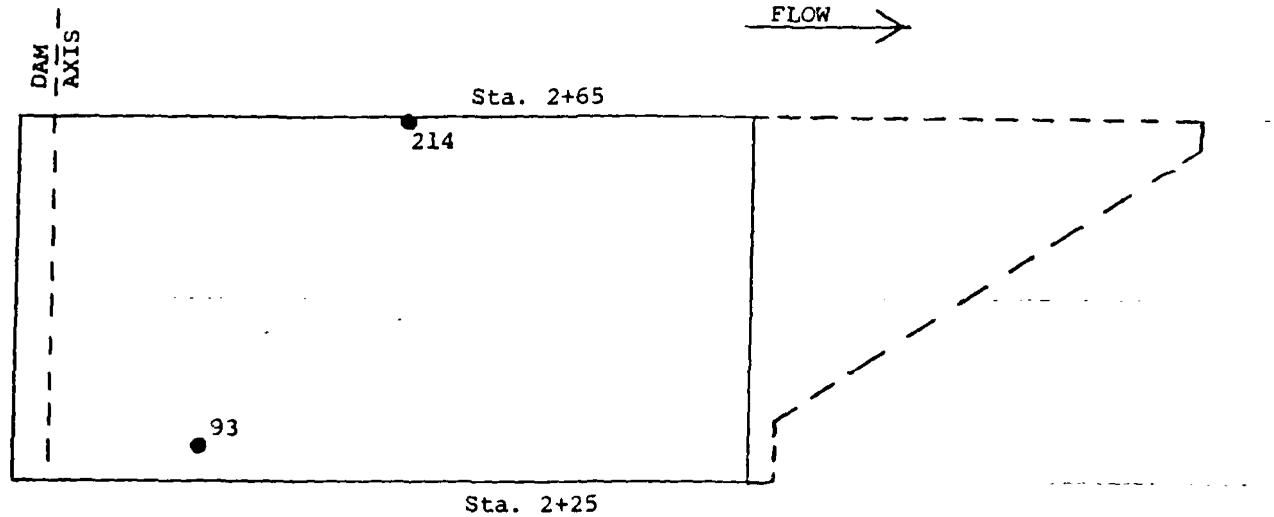
U.S. ARMY, HUNTINGTON DISTRICT
CORPS OF ENGINEERS
FOUNDATION REPORT
WEST FORK RIVER, WEST VIRGINIA
STONEWALL JACKSON DAM

STATISTICAL DATA
MONOLITH - 4

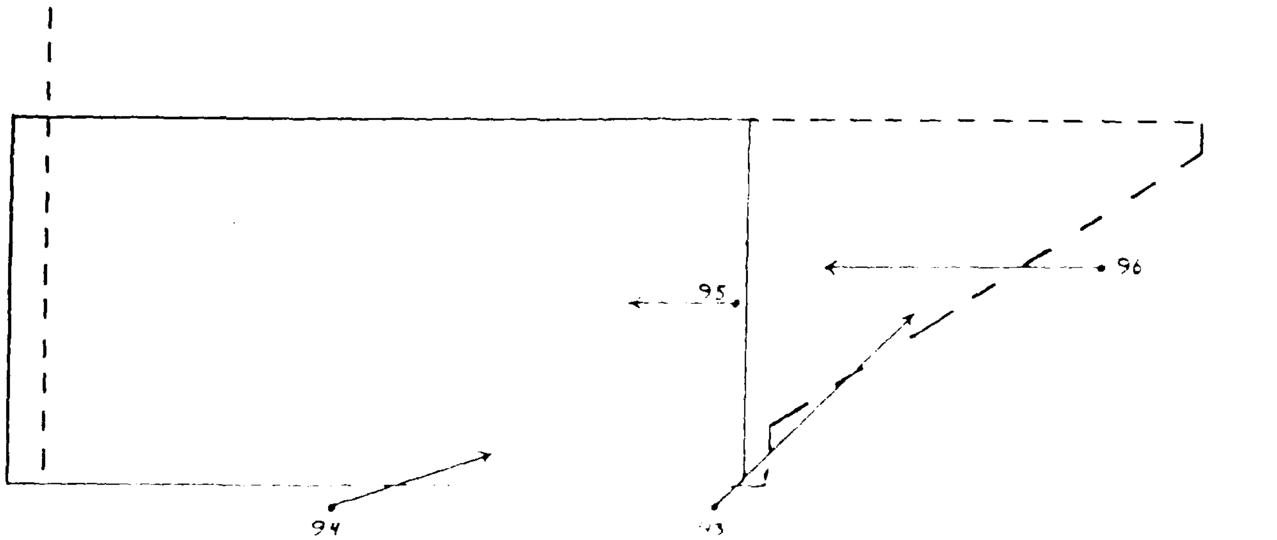
EXHIBIT NO. 9-4A

MONOLITH 4

FOUNDING ELEV. 995.6



EXPLORATORY BORINGS



PHOTOGRAPHS

U.S. ARMY, HUNTINGTON DISTRICT
CORPS OF ENGINEERS

FOUNDATION REPORT
WEST FORK RIVER, WEST VIRGINIA
STONEWALL JACKSON DAM

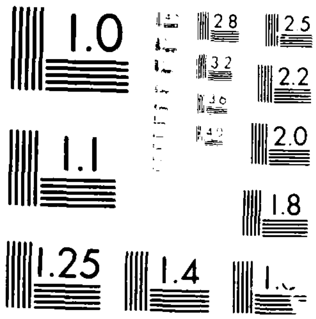
EXPLORATORY BORINGS
INSTRUMENTATION
PHOTOGRAPHS

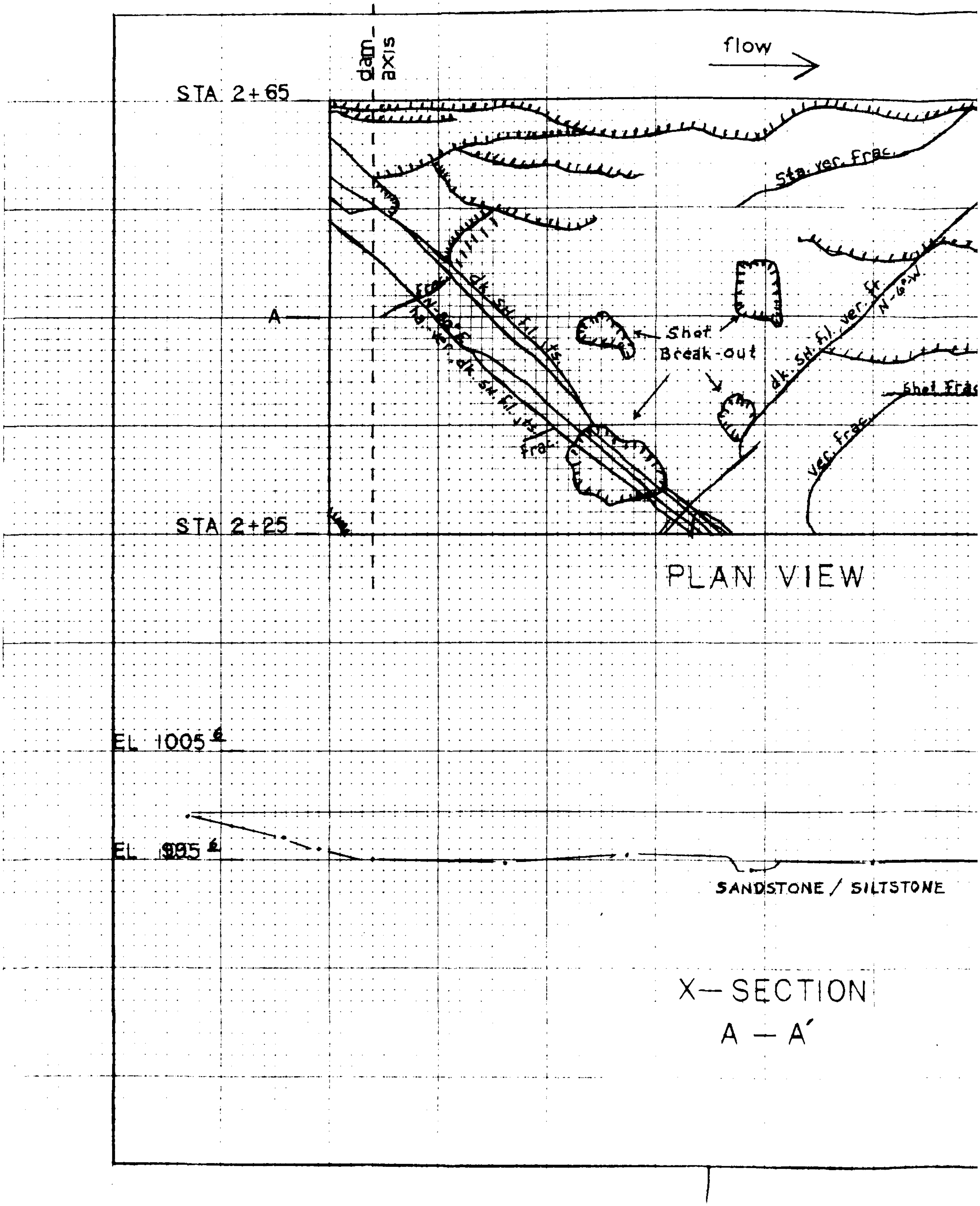
Scale: 1" = 20'   PLAN VIEW

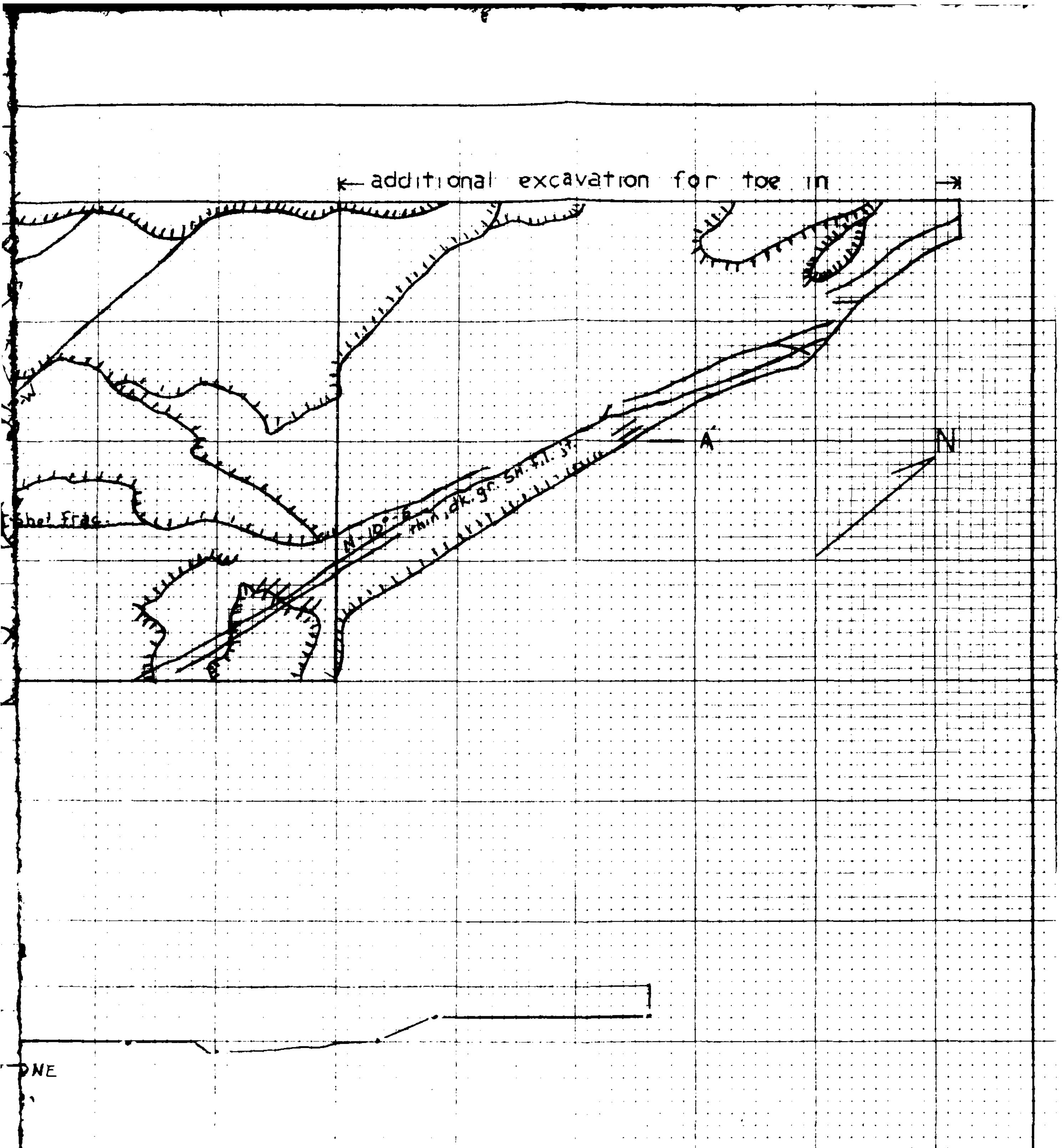
EXHIBIT NO. 9-4B

AD-A191 144 FOUNDATION REPORT ON STONEWALL JACKSON DAM WEST FORK RIVER BASIN WESTON W. (U) CORPS OF ENGINEERS HUNTINGTON WV HUNTINGTON DISTRICT D NUGEN 21 DEC 87 5/6

UNCLASSIFIED DACW59-83-C-0053 F/G 13/2 NL


1.0
2.8
2.5
3.2
2.2
2.0
1.1
1.8
1.25
1.4


dam axis
flow
STA 2+65
Sta. ver. Frac.
A
dk. sh. fl. jts.
Shot
Break-out
dk. sh. fl. ver. fr.
ver. Frac.
Frac.
STA 2+25
PLAN VIEW
EL 1005
SANDSTONE / SILTSTONE
X—SECTION
A — A′



U.S. ARMY, HUNTINGTON DISTRICT
CORPS OF ENGINEERS

FOUNDATION REPORT
WEST FORK RIVER, WEST VIRGINIA
STONEWALL JACKSON DAM

FOUNDATION GEOLOGY
MONOLITH - 4

Scale: 1" = 10'   PLAN VIEW

EXHIBIT NO. 9-4C

FOUNDATION GEOLOGY

MONOLITH NO. 5

LOCATION: Dam Monolith STATION: 2+65 to 3+10

REFERENCE EXPLORATORY BORINGS:
(1) Pre-contract: 45, 63

(2) During Contract: 213

FOUNDATION:
(1) Elevation: 987.4

(2) Dimensions: Width 45' 0"; Length 95' 1"/105' 8"

(3) Description: Hard, fine grained, medium gray, silty sandstone with ungulating bedding

(4) Special or Unusual Conditions: Installed 6 uplift cells: Sheared bedding plane at approximate elevation 990 exposed in upstream, downstream, and right side excavated faces; few high angle to vertical fractures and joints running lengthwise of floor

(5) Treatment: Standard final clean-up

(6) Dewatering: Standard small sump pumps used during concrete placement

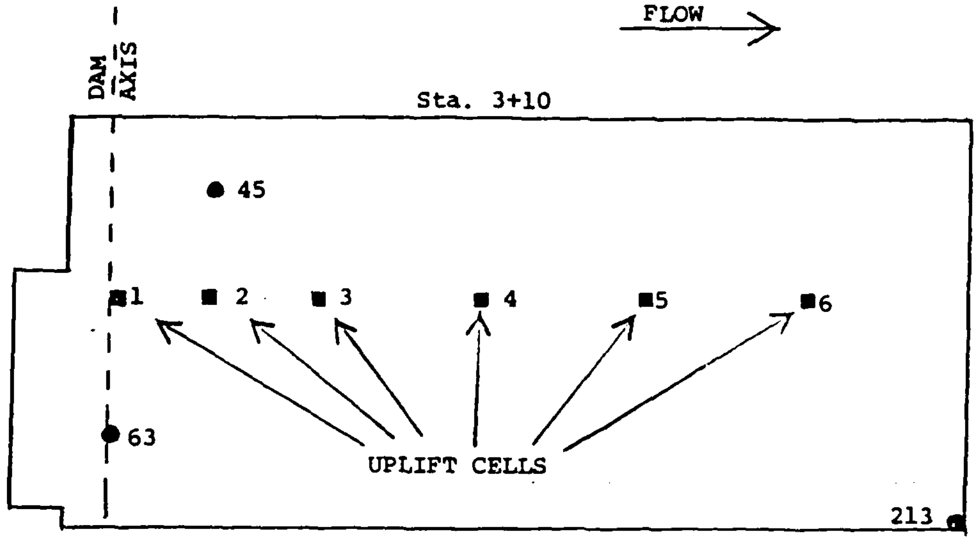
(7) Instrumentation: Uplift cells No. 1-6

(8) Photographs: 51 to 62
(See Volume II of this report)

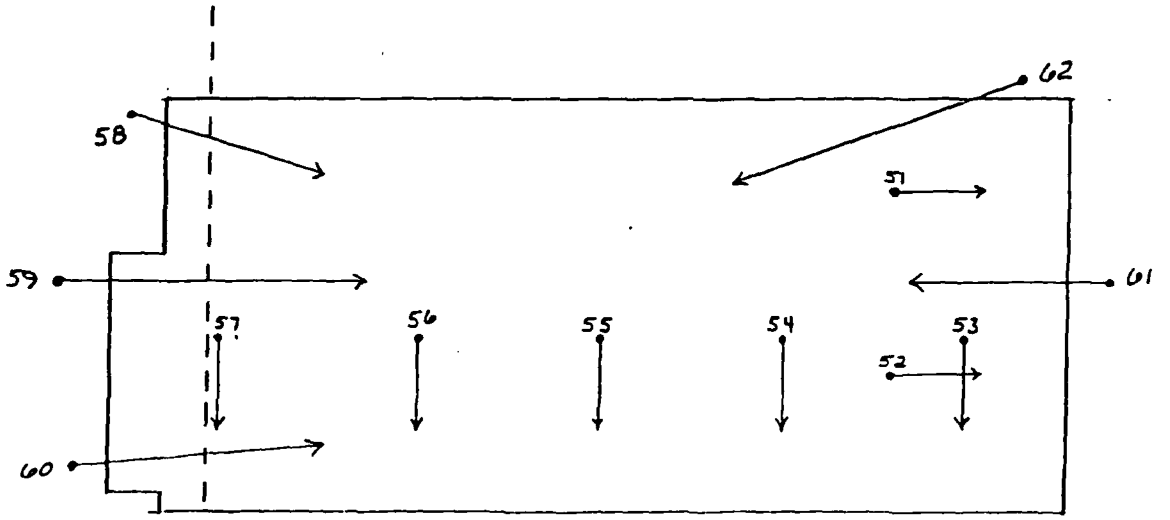
(9) First Placement: 27 June 1984

MONOLITH 5

FOUNDING ELEV. 987.4



EXPLORATORY BORINGS



PHOTOGRAPHS

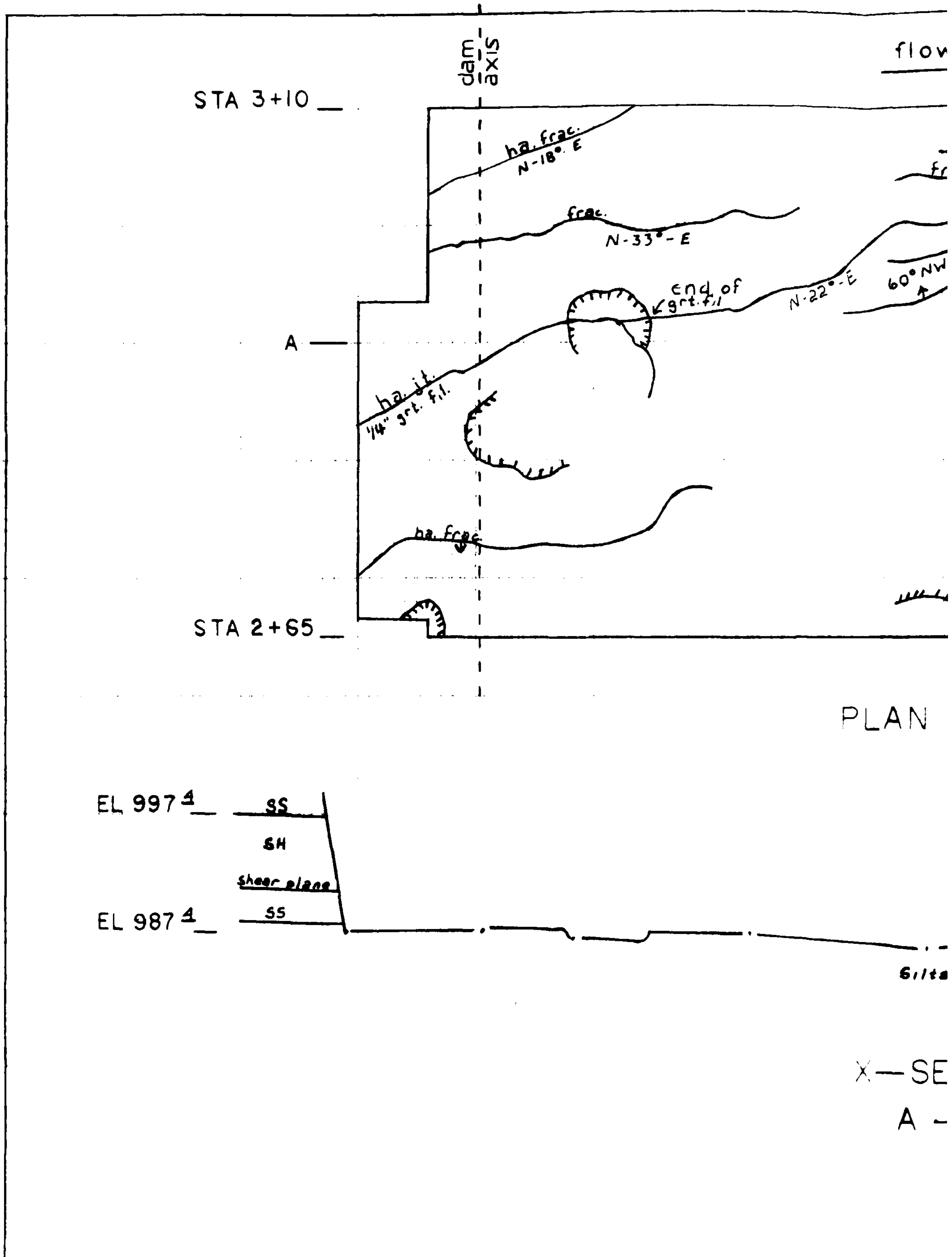
U.S. ARMY, HUNTINGTON DISTRICT
CORPS OF ENGINEERS

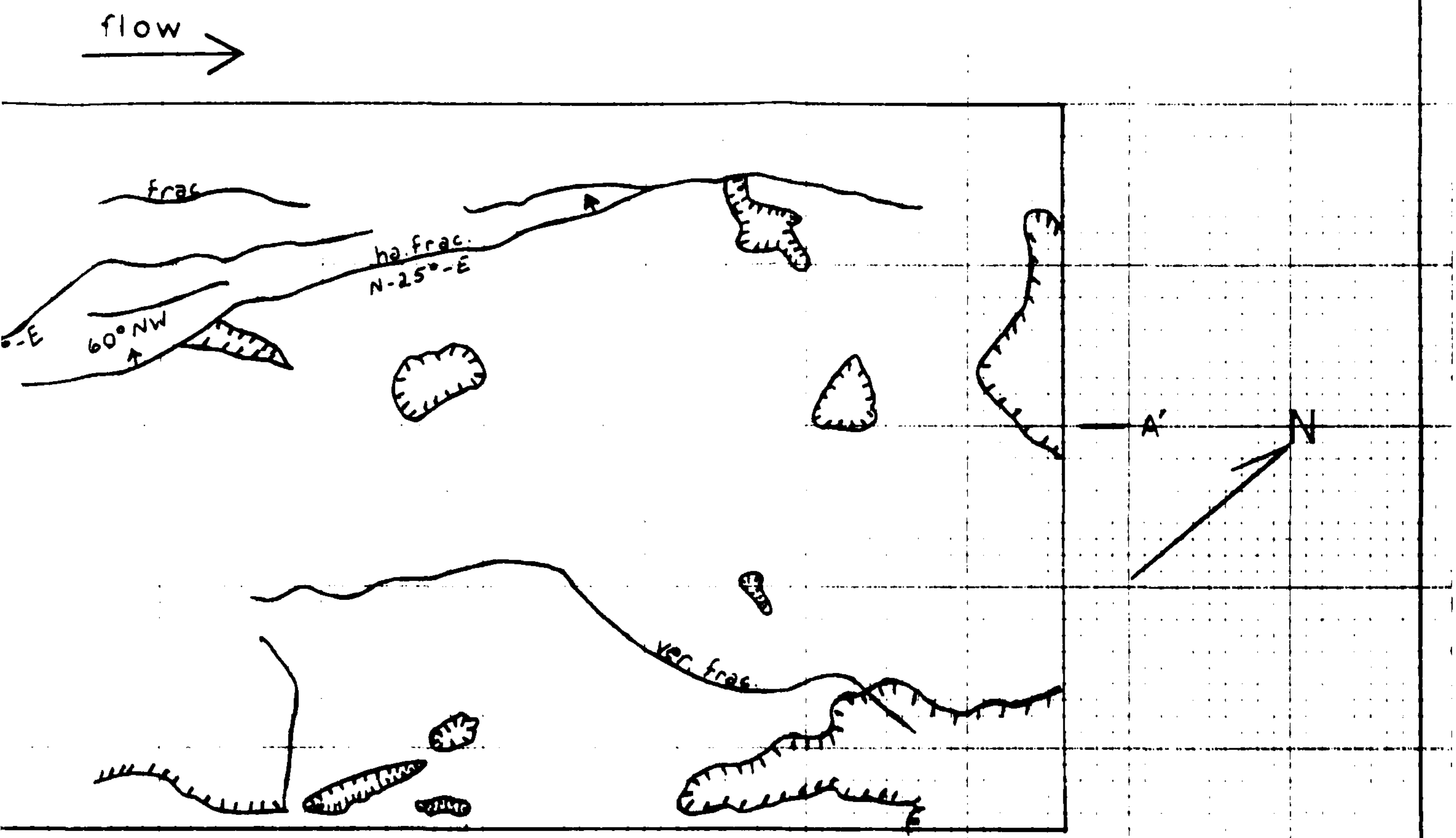
FOUNDATION REPORT
WEST FORK RIVER, WEST VIRGINIA
STONEWALL JACKSON DAM

EXPLORATORY BORINGS
INSTRUMENTATION
PHOTOGRAPHS

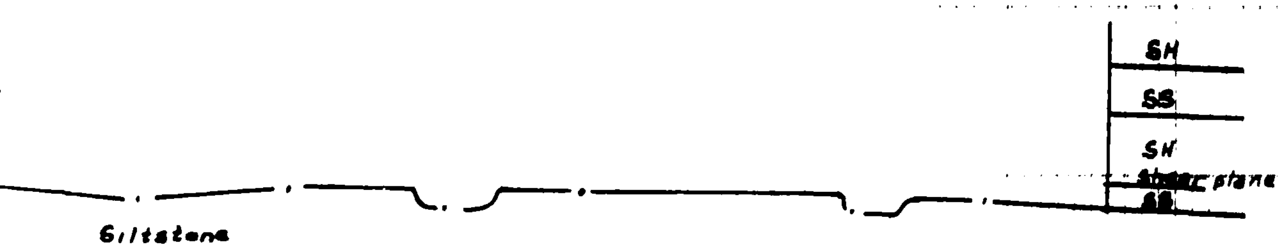
Scale: 1" = 20' PLAN VIEW

EXHIBIT NO. 9-5B


dam axis
flow
STA 3+10
STA 2+65
A
ha. frac.
N-18°-E
frac.
N-33°-E
end of grt. fil
N-22°-E
60°NW
ha. jt.
1/4" grt. f.l.
ha. frac.
PLAN
EL 997±
EL 987±
SS
SH
shear plane
SS
X—SE
A -



PLAN VIEW



X—SECTION
A — A′

U.S. ARMY, HUNTINGTON DISTRICT
CORPS OF ENGINEERS

FOUNDATION REPORT
WEST FORK RIVER, WEST VIRGINIA
STONEWALL JACKSON DAM

FOUNDATION GEOLOGY
MONOLITH - 5

Scale: 1" = 10' PLAN VIEW

EXHIBIT NO. 9-5C

2

FOUNDATION GEOLOGY

MONOLITH NO. 6

LOCATION: Dam Monolith STATION: 3+10 to 3+45

REFERENCE EXPLORATORY BORINGS:
(1) Pre-contract: 72, 111A

(2) During Contract: 201, 211

FOUNDATION:
(1) Elevation: 987.4

(2) Dimensions: Width 35' 0"; Length 98' 3-5/8"

(3) Description: Thin bedded, fine grained, silty sandstone with shaley laminations

(4) Special or Unusual Conditions: Several high angle to vertical fractures in foundation floor

(5) Treatment: 22 cubic yards of dental concrete placed on 15 June 1984 to fill overbrake area along Monolith 6/7 face: standard final clean-up

(6) Dewatering: 2-4 in. diameter PVC pipes were installed vertically along water producing joint in foundation floor: After being used for dewatering during concrete placement, these pipes were backfilled with neat grout at elevation 995.5

(7) Instrumentation: None

(8) Photographs: 82 to 87
(See Volume II of this report

(9) First Placement: 26 July 1984

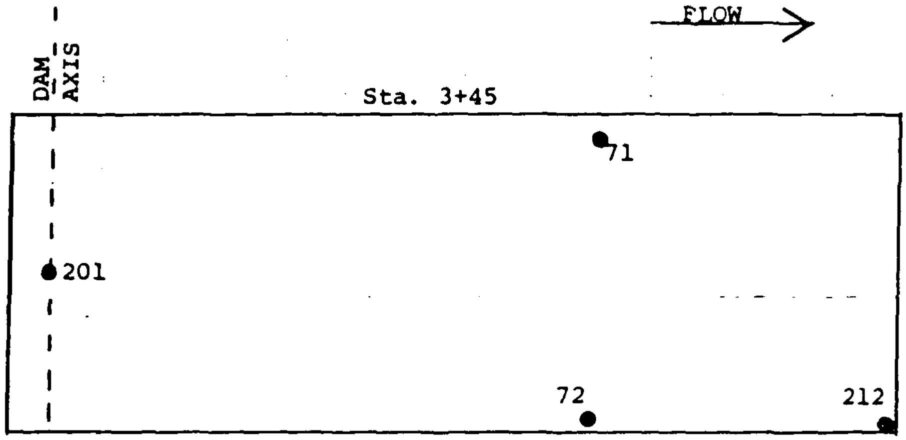
U.S. ARMY, HUNTINGTON DISTRICT
CORPS OF ENGINEERS
FOUNDATION REPORT
WEST FORK RIVER, WEST VIRGINIA
STONEWALL JACKSON DAM

STATISTICAL DATA
MONOLITH - 6

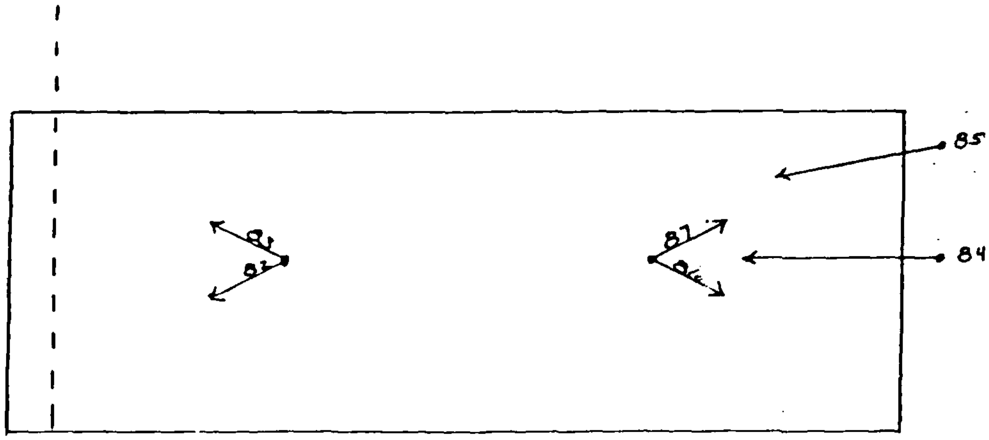
EXHIBIT NO. 9-6A

MONOLITH 6

FOUNDING ELEV. 987.4



EXPLORATORY BORINGS



PHOTOGRAPHS

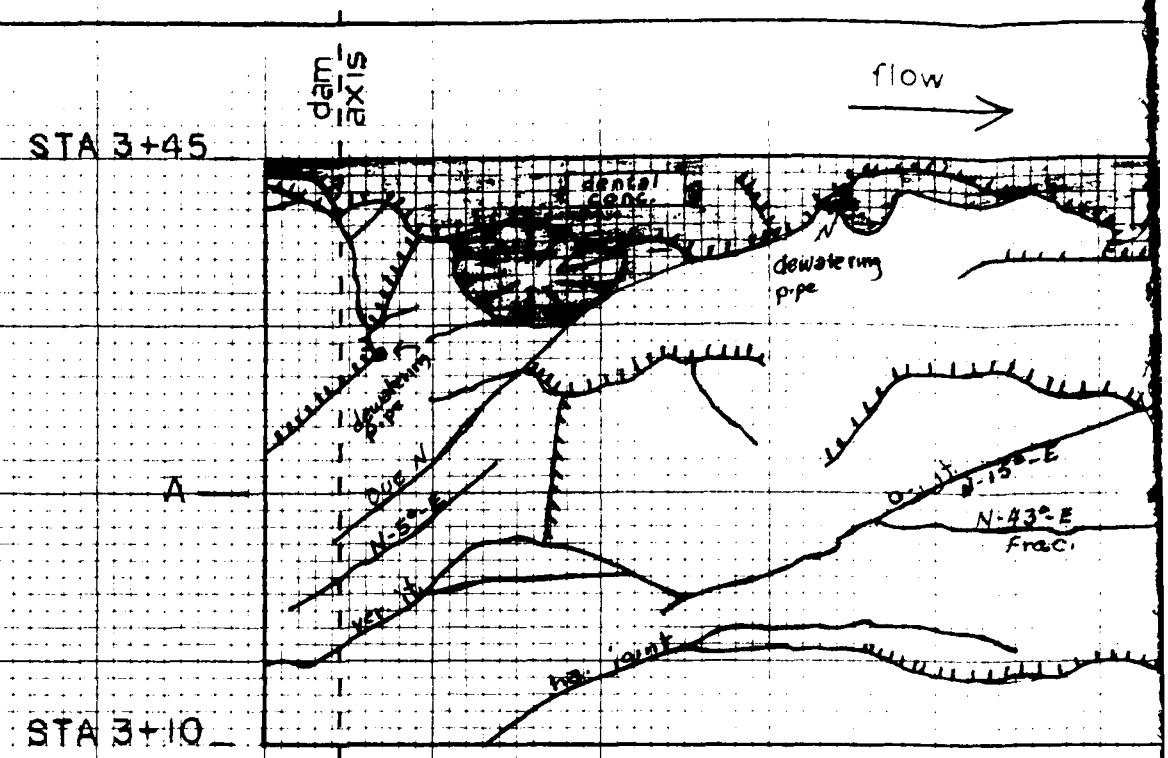
U.S. ARMY, HUNTINGTON DISTRICT
CORPS OF ENGINEERS

FOUNDATION REPORT
WEST FORK RIVER, WEST VIRGINIA
STONEWALL JACKSON DAM

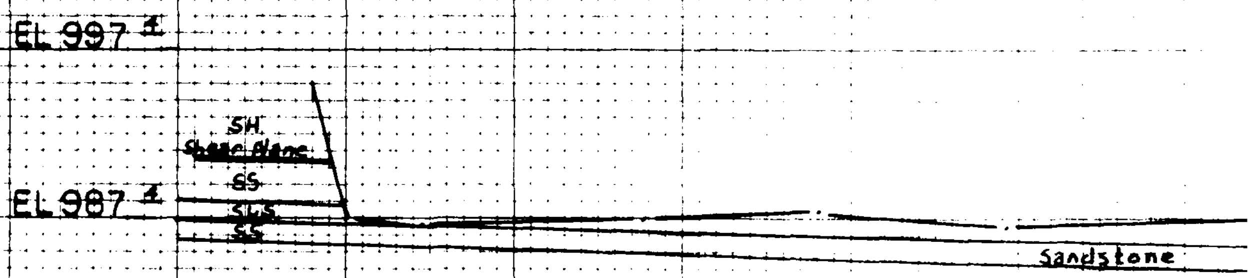
EXPLORATORY BORINGS
INSTRUMENTATION
PHOTOGRAPHS

Scale: 1" = 20'   PLAN VIEW

EXHIBIT NO. 9-68

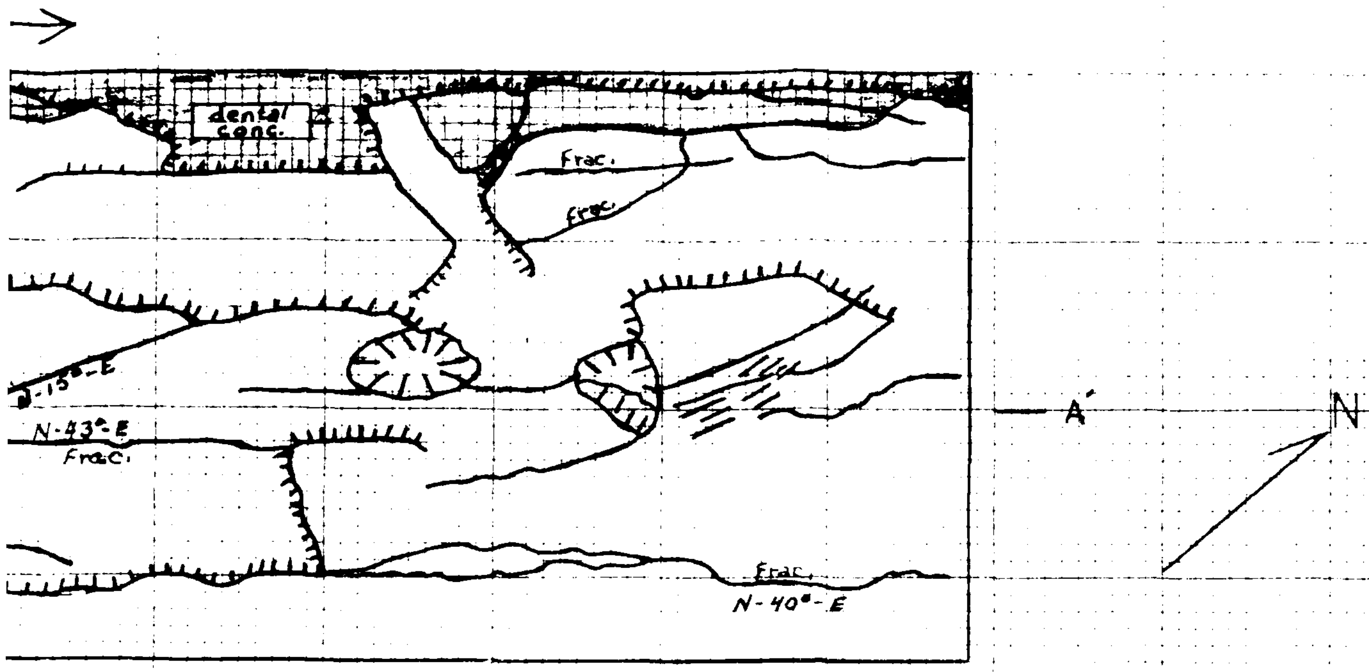


PLAN V

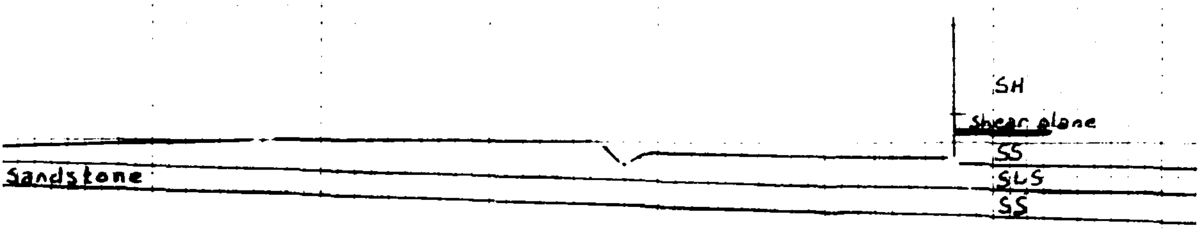


X — SECT

A —



PLAN VIEW



X — SECTION

A — A'

U.S. ARMY, HUNTINGTON DISTRICT
CORPS OF ENGINEERS

FOUNDATION REPORT
WEST FORK RIVER, WEST VIRGINIA
STONEWALL JACKSON DAM

FOUNDATION GEOLOGY
MONOLITH - 6

Scale: 1" = 10' PLAN VIEW

EXHIBIT NO. 9-6C

FOUNDATION GEOLOGY

MONOLITH NO. 7

LOCATION: Dam Monolith STATION: 3+45 to 3+80

REFERENCE EXPLORATORY BORINGS:
(1) Pre-contract: 43, 62, 71

(2) During Contract: 211

FOUNDATION:
(1) Elevation: 985.0

(2) Dimensions: Width 35' 0"; Length 100' 6-1/2"

(3) Description: Thin bedded, silty sandstone and sandy shale

(4) Special or Unusual Conditions: None

(5) Treatment: Standard final clean-up

(6) Dewatering: Standard small sump pumps used during concrete placement

(7) Instrumentation: None

(8) Photographs: 45 to 48
(See Volume II of this report)

(9) First Placement: 12 June 84

U.S. ARMY, HUNTINGTON DISTRICT
CORPS OF ENGINEERS
FOUNDATION REPORT
WEST FORK RIVER, WEST VIRGINIA
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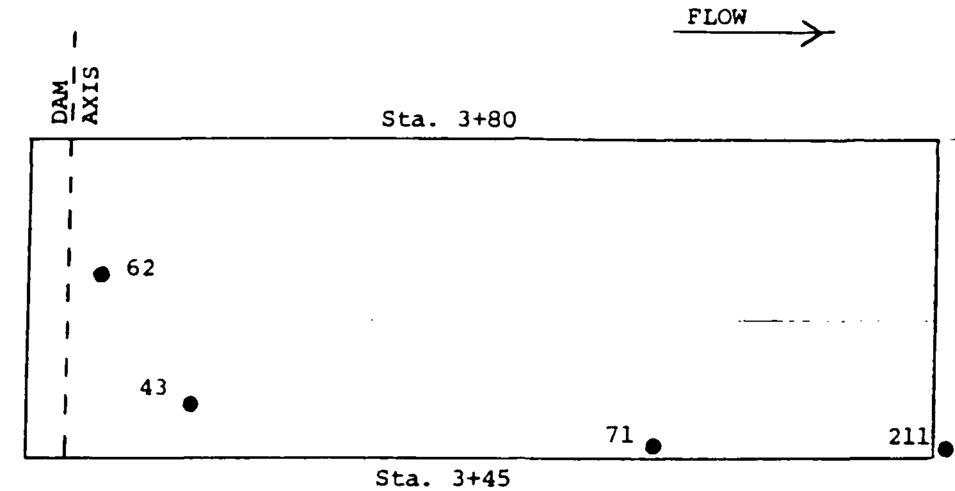
STATISTICAL DATA
MONOLITH - 7

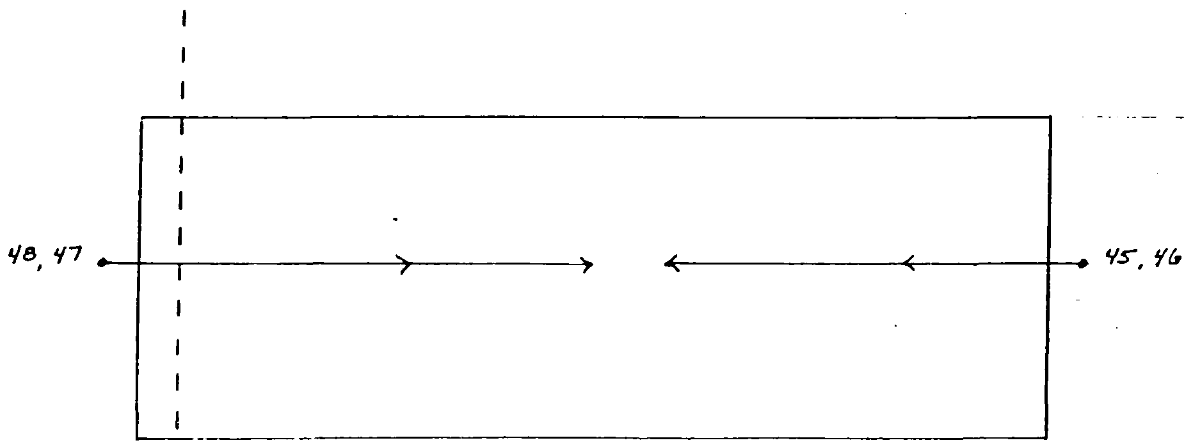
EXHIBIT NO. 9-7A

MONOLITH 7

FOUNDING ELEV. 985



EXPLORATORY BORINGS



PHOTOGRAPHS

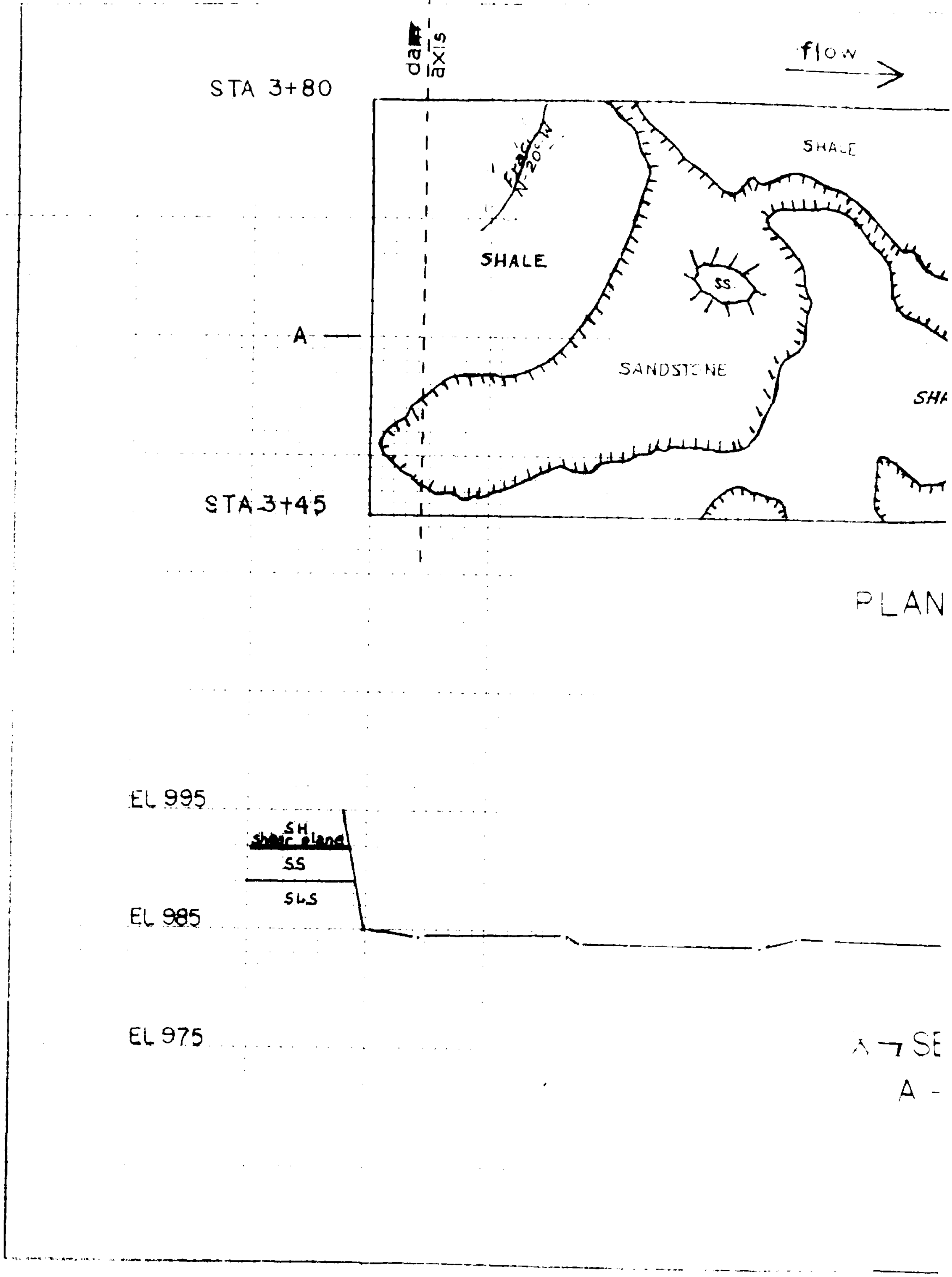
U.S. ARMY, HUNTINGTON DISTRICT
CORPS OF ENGINEERS

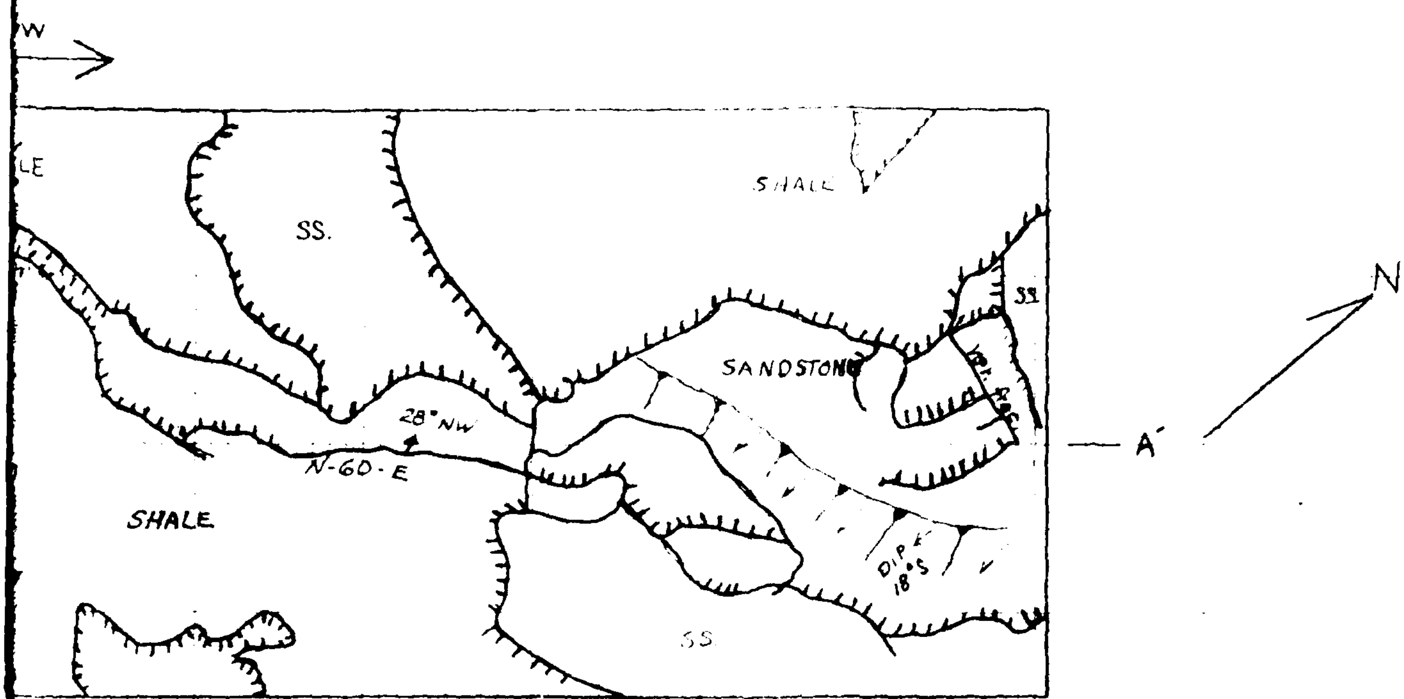
FOUNDATION REPORT
WEST FORK RIVER, WEST VIRGINIA
STONEWALL JACKSON DAM

EXPLORATORY BORINGS
INSTRUMENTATION
PHOTOGRAPHS

Scale: 1" = 20' PLAN VIEW

EXHIBIT NO. 9-7B


dam axis
flow
STA 3+80
SHALE
SHALE
Frac. N 20° W
SS
SANDSTONE
A
STA 3+45
PLAN
EL 995
SH
shear plane
SS
SLS
EL 985
EL 975



PLAN VIEW

SECTION
A — A´

U.S. ARMY, HUNTINGTON DISTRICT
CORPS OF ENGINEERS
FOUNDATION REPORT
WEST FORK RIVER, WEST VIRGINIA
STONEWALL JACKSON DAM

FOUNDATION GEOLOGY
MONOLITH - 7

Scale 1" = 10' PLAN VIEW

EXHIBIT NO. 9-7C

FOUNDATION GEOLOGY

MONOLITH NO. 8

LOCATION: Dam Monolith STATION: 3+80 to 4+15

REFERENCE EXPLORATORY BORINGS:
(1) Pre-contract: 70

(2) During Contract: 202, 210

FOUNDATION:
(1) Elevation: 985.0

(2) Dimensions: Width 35' 0"; Length 100' 6-1/2"

(3) Description: Thin bedded, silty sandstone and sandy shale

(4) Special or Unusual Conditions: Water flowing from several open joints and bedding planes near area of deeper excavation for sump

(5) Treatment: Standard final clean-up

(6) Dewatering: 5-4 in. diameter dewatering pipes were installed vertically at water producing joints and bedding planes: Pumped during cncrete placement: Tremie grouted at elevation 990. One pipe tremie grouted at elevation 1000

(7) Instrumentation: Uplift cells No. 7-12

(8) Photographs: 74 to 81
(See Volume II of this report)

(9) First Placement: 10 July 1984

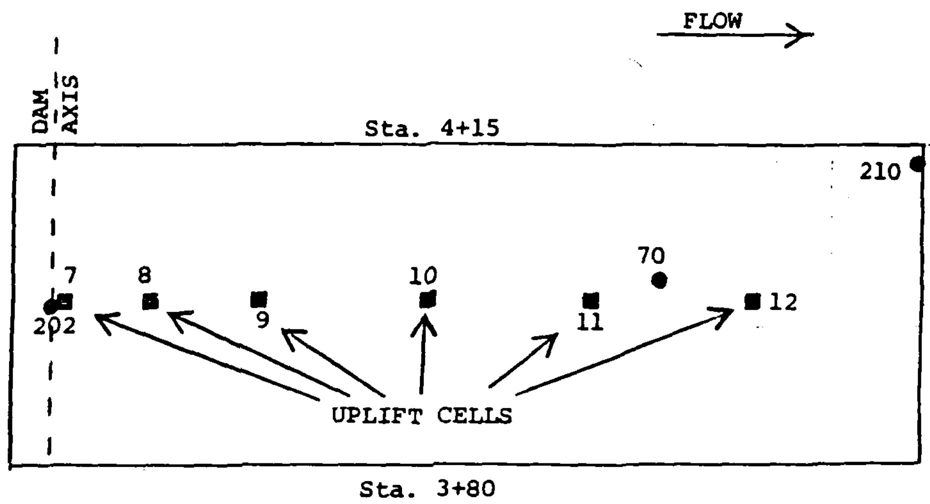
U.S. ARMY, HUNTINGTON DISTRICT
CORPS OF ENGINEERS
FOUNDATION REPORT
WEST FORK RIVER, WEST VIRGINIA
STONEWALL JACKSON DAM

STATISTICAL DATA
MONOLITH - 8

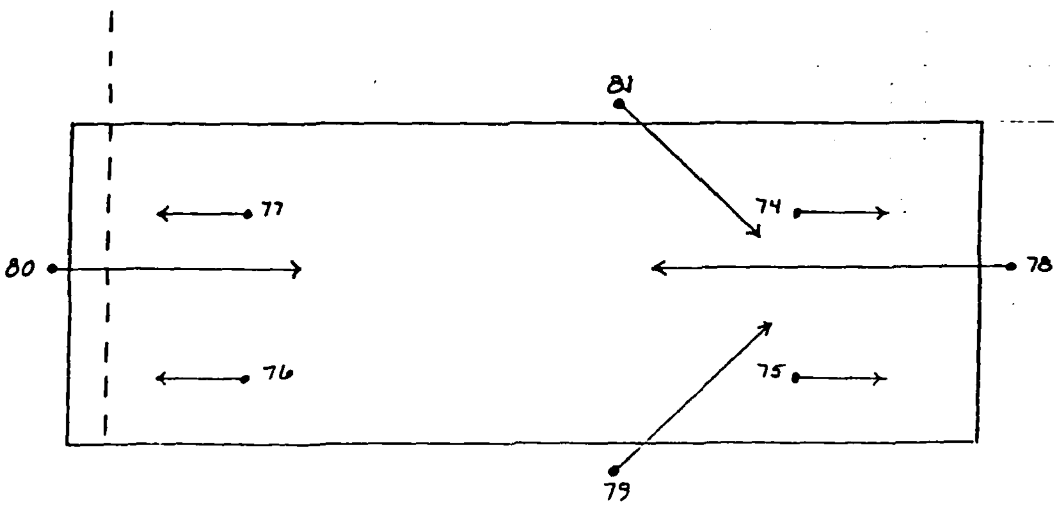
EXHIBIT NO. 9-8A

MONOLITH 8

FOUNDING ELEV. 985



EXPLORATORY BORINGS



PHOTOGRAPHS

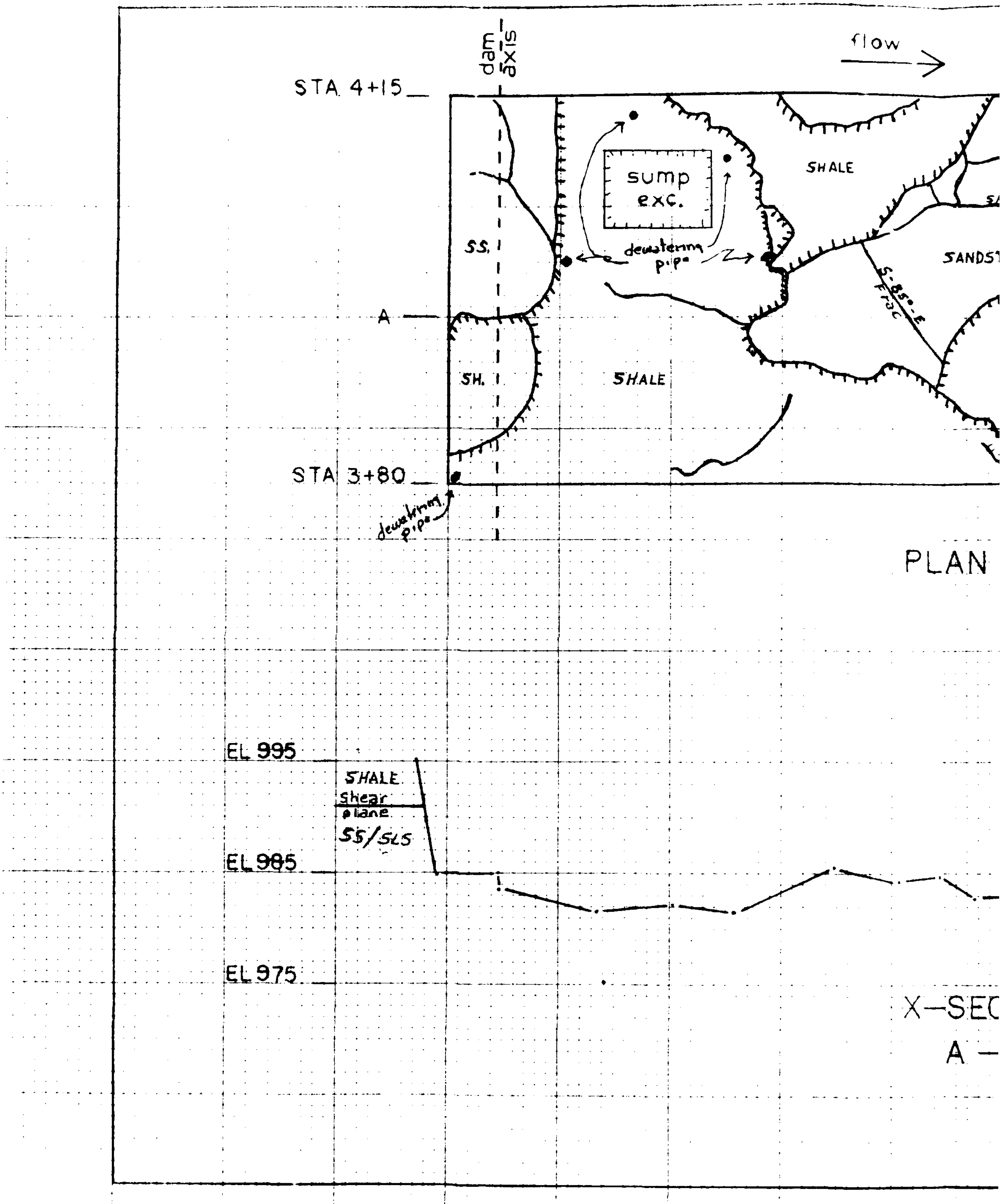
U.S. ARMY, HUNTINGTON DISTRICT
CORPS OF ENGINEERS

FOUNDATION REPORT
WEST FORK RIVER, WEST VIRGINIA
STONEWALL JACKSON DAM

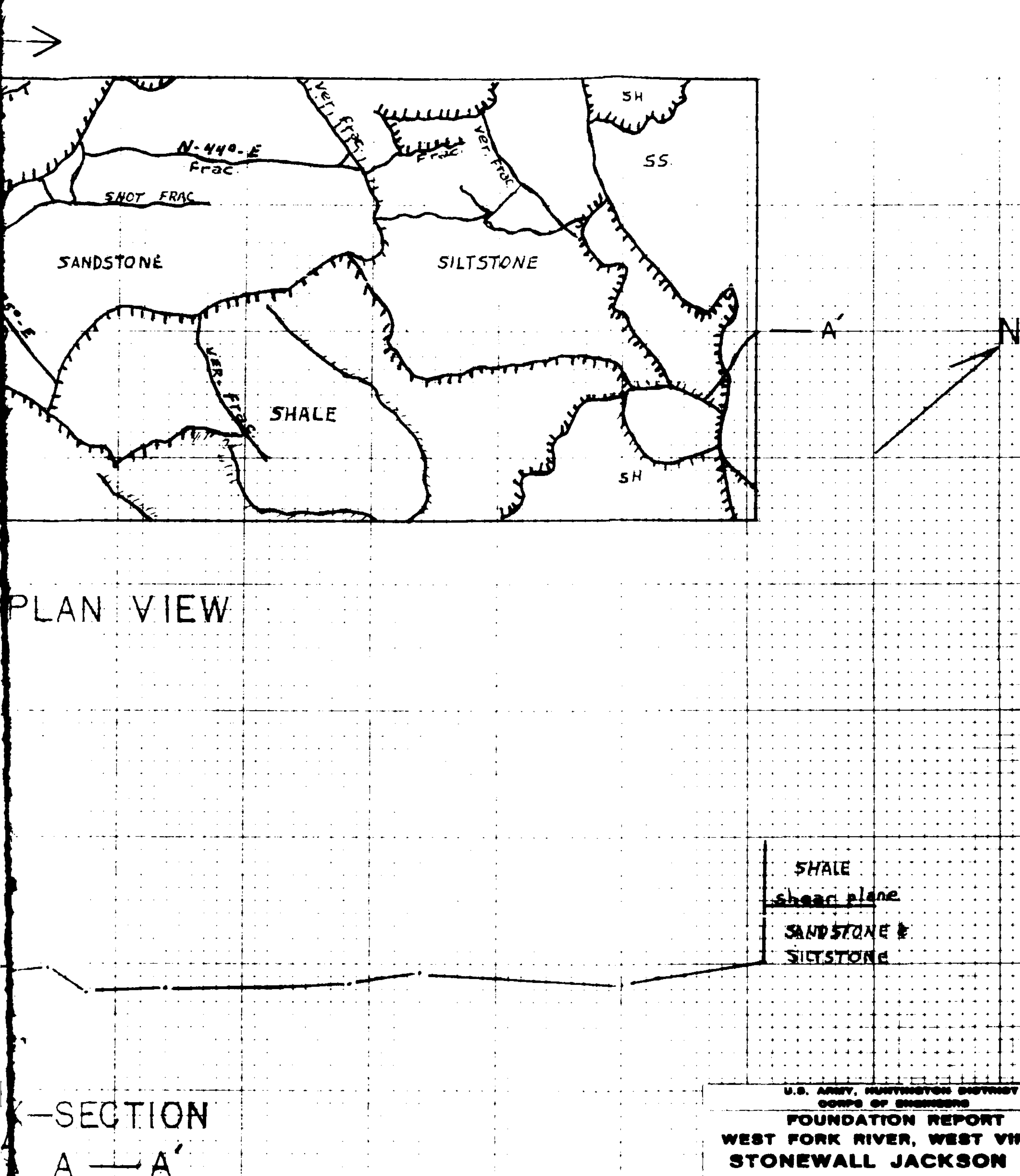
EXPLORATORY BORINGS
INSTRUMENTATION
PHOTOGRAPHS

Scale: 1" = 20' PLAN VIEW

EXHIBIT NO. 9-8B



flow
dam axis
STA 4+15
sump exc.
dewatering pipe
SHALE
SS.
SANDST
A
SH.
SHALE
STA 3+80
dewatering pipe
PLAN
EL 995
SHALE
shear plane
SS/SLS
EL 985
EL 975
X-SEC
A -



U.S. ARMY, HUNTINGTON DISTRICT
CORPS OF ENGINEERS

FOUNDATION REPORT
WEST FORK RIVER, WEST VIRGINIA
STONEWALL JACKSON DAM

FOUNDATION GEOLOGY
MONOLITH - 8

Scale: 1" = 10' PLAN VIEW

EXHIBIT NO. 9-8C

FOUNDATION GEOLOGY

MONOLITH NO. 9

LOCATION: Dam Monolith STATION: 4+15 to 4+60

REFERENCE EXPLORATORY BORINGS:
(1) Pre-contract: 61, 69, 105

(2) During Contract: 210

FOUNDATION:
(1) Elevation: 985.0

(2) Dimensions: Width 45' 0"; Length 95' 9-1/4"/ 106' 4-1/4"

(3) Description: Thin to medium bedded, fine grained, silty sandstone and sandy shale

(4) Special or Unusual Conditions: None

(5) Treatment: 2 cubic yards of dental concrete placed along irregular bedding plane: Plug concrete placement made to fill contractor's Stage 1 sump excavation area

(6) Dewatering: Standard small sump pumps used during concrete placement

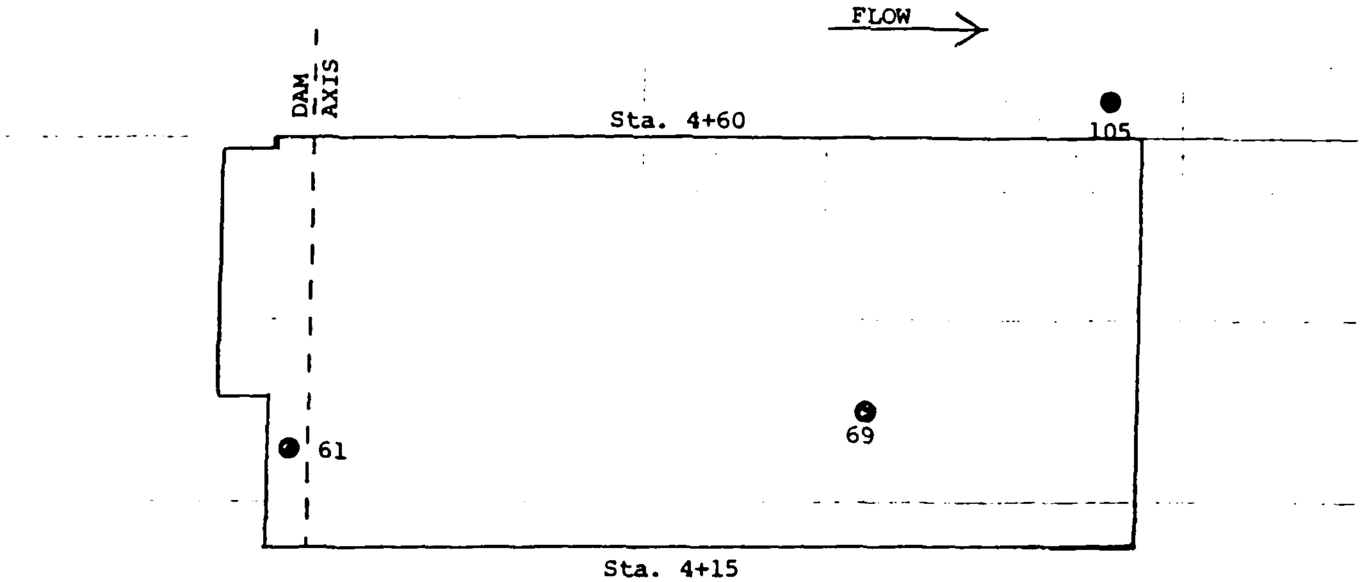
(7) Instrumentation: None

(8) Photographs: 32 to 37 (See Volume II of this report)

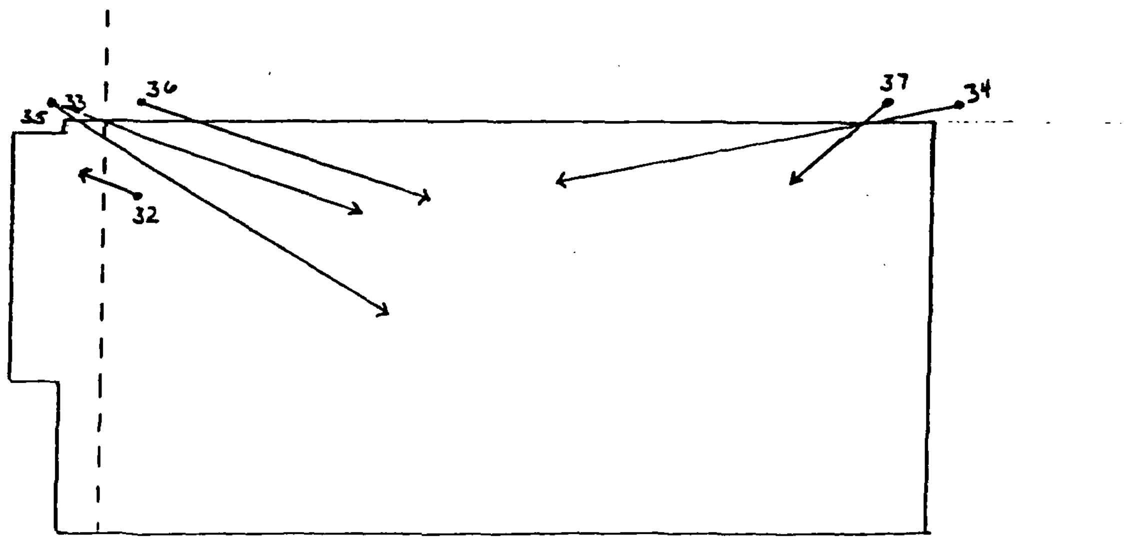
(9) First Placement: 06 June 1984

MONOLITH 9

FOUNDING ELEV. 985



EXPLORATORY BORINGS



PHOTOGRAPHS

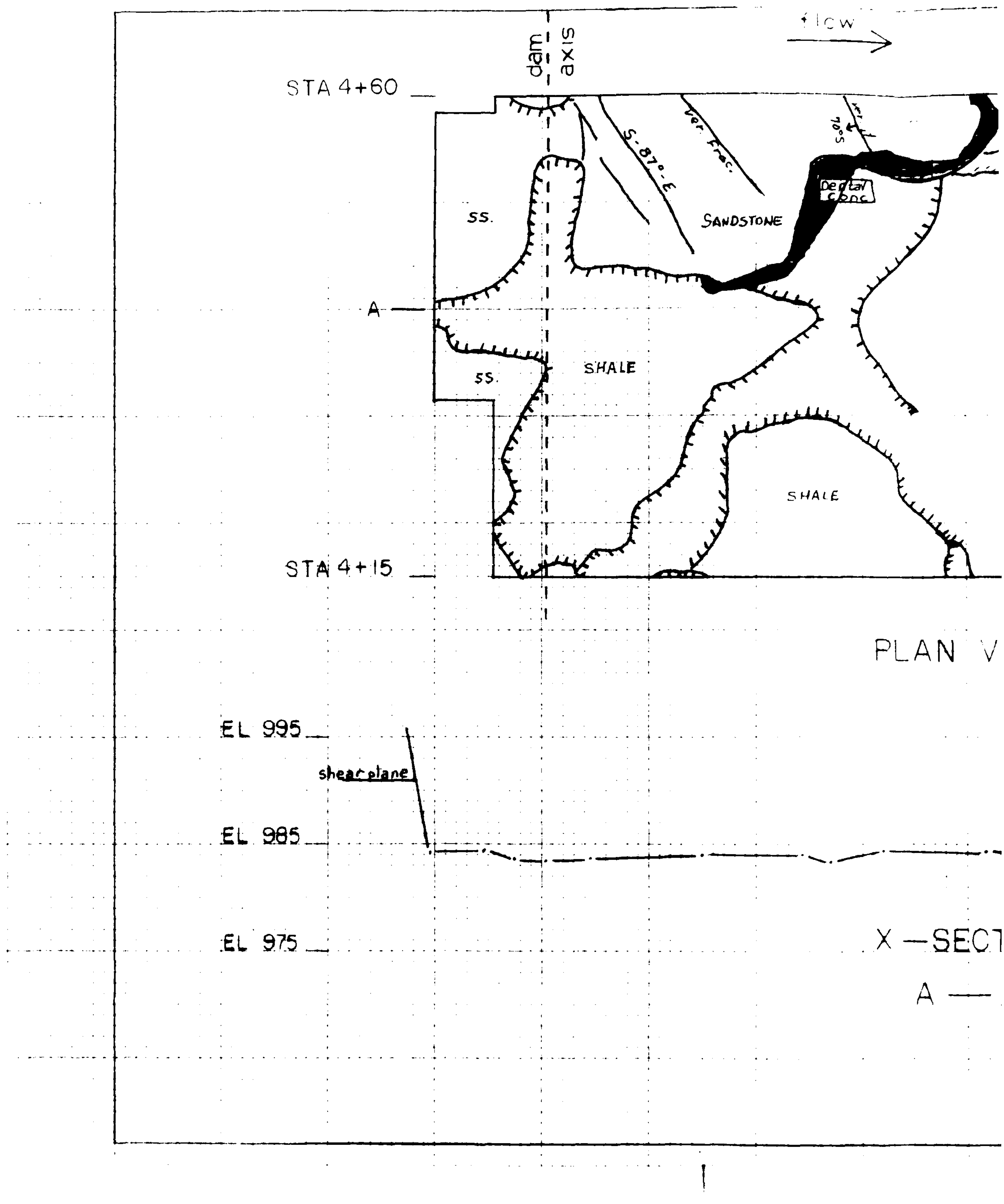
U.S. ARMY, HUNTINGTON DISTRICT
CORPS OF ENGINEERS

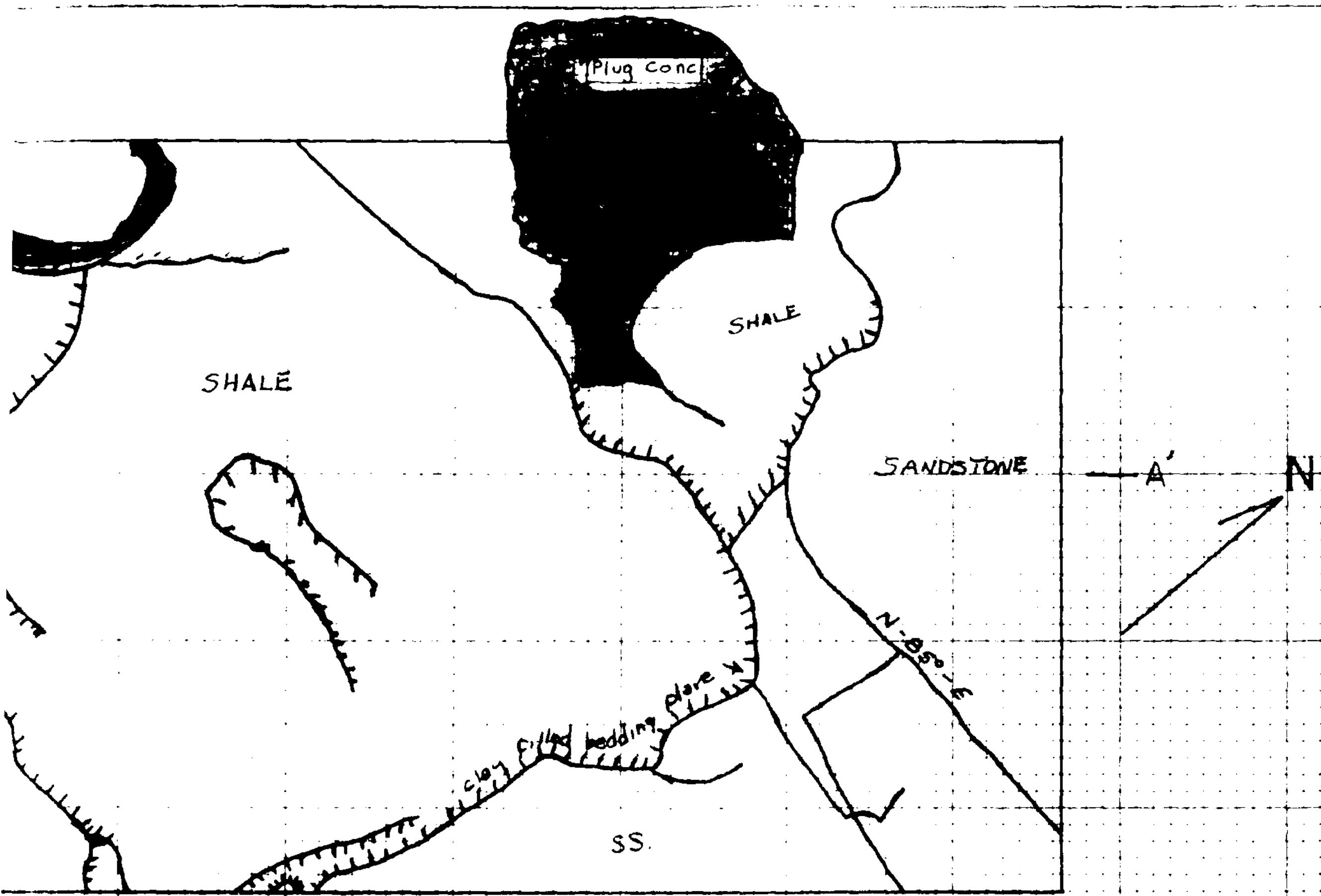
FOUNDATION REPORT
WEST FORK RIVER, WEST VIRGINIA
STONEWALL JACKSON DAM

EXPLORATORY BORINGS
INSTRUMENTATION
PHOTOGRAPHS

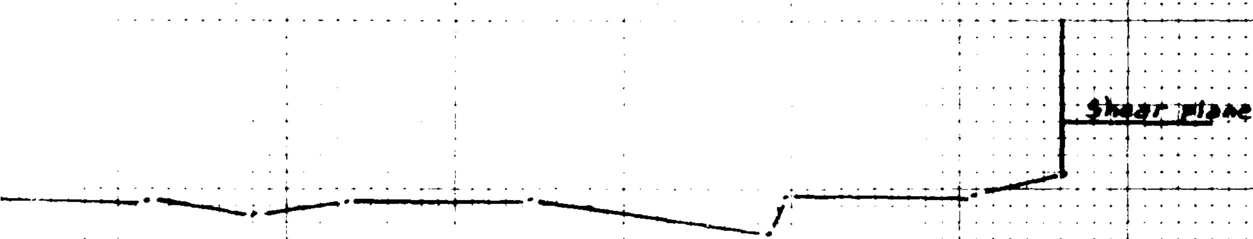
Scale: 1" = 20'   PLAN VIEW

EXHIBIT NO. 9.98


flow
dam axis
STA 4+60
STA 4+15
A
SS.
SS.
SHALE
SHALE
SANDSTONE
S-87°-E
Ver. Frac.
70°S
Dental Conc.
PLAN V
EL 995
EL 985
EL 975
shear plane
X —SECT
A —



LAN VIEW



--SECTION
A — A'

U.S. ARMY, HUNTINGTON DISTRICT
CORPS OF ENGINEERS
FOUNDATION REPORT
WEST FORK RIVER, WEST VIRGINIA
STONEWALL JACKSON DAM

FOUNDATION GEOLOGY
MONOLITH - 9

Scale: 1" = 10' PLAN VIEW

EXHIBIT NO. 9-9C

FOUNDATION GEOLOGY

MONOLITH NO. 10

LOCATION: Dam Monolith STATION: 4+60 to 5+00

REFERENCE EXPLORATORY BORINGS:

(1) Pre-contract: 60, 92, 94, 100, 103A, 104

(2) During Contract: 209

FOUNDATION:

(1) Elevation: 985.0

(2) Dimensions: Width 40′ 0"; Length 88′ 6-7/16"

(3) Description: Near horizontal, thin bedded, fine grained, silty sandstone and sandy siltstone

(4) Special or Unusual Conditions: None

(5) Treatment: Stage 1 sump area that was backfilled with concrete extended into this monolith from Monolith No. 9

(6) Dewatering: Standard small sump pumps used during concrete placement

(7) Instrumentation: None

(8) Photographs: 169 to 181
(See Volume II of this report)

(9) First Placement: 20 April 1985

U.S. ARMY, HUNTINGTON DISTRICT
CORPS OF ENGINEERS

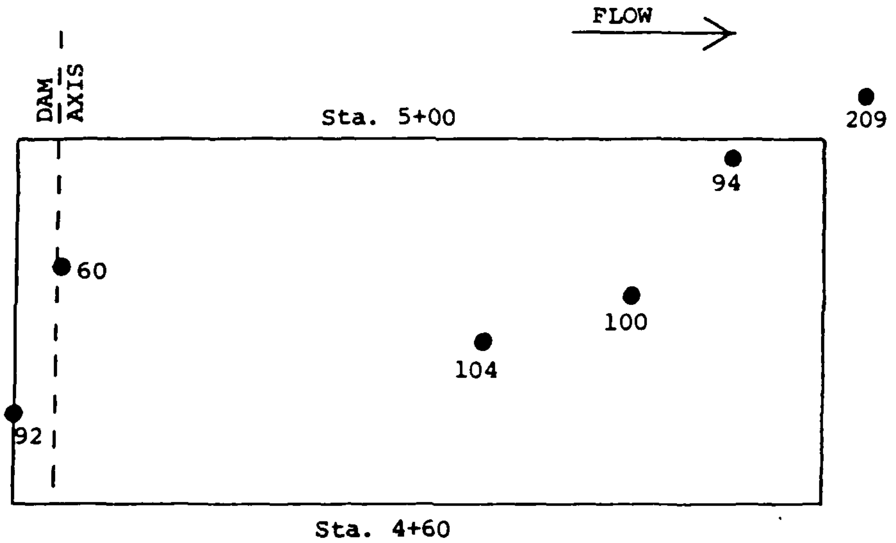
FOUNDATION REPORT
WEST FORK RIVER, WEST VIRGINIA
STONEWALL JACKSON DAM

STATISTICAL DATA
MONOLITH - 10

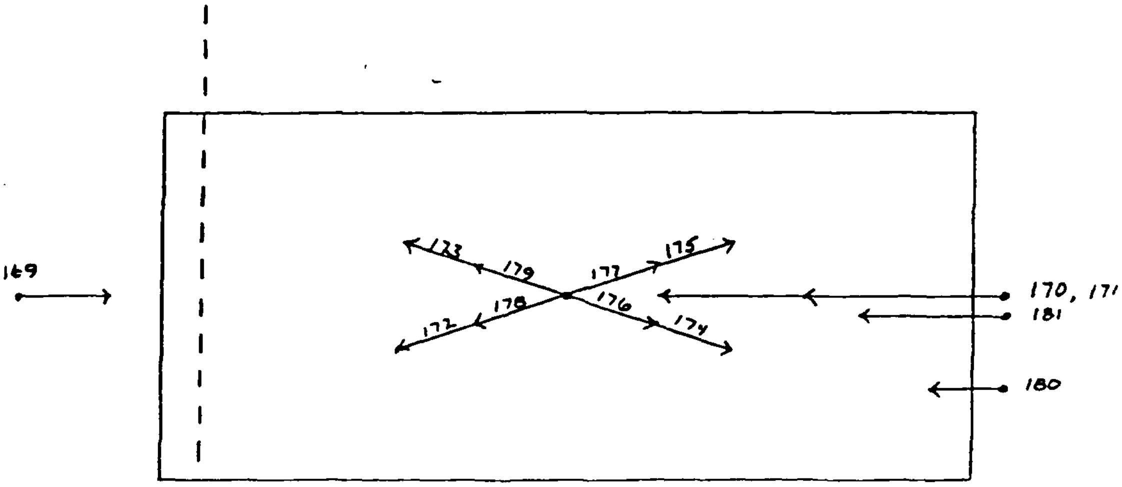
EXHIBIT NO. 9-10A

MONOLITH 10

FOUNDING ELEV. 985



EXPLORATORY BORINGS



PHOTOGRAPHS

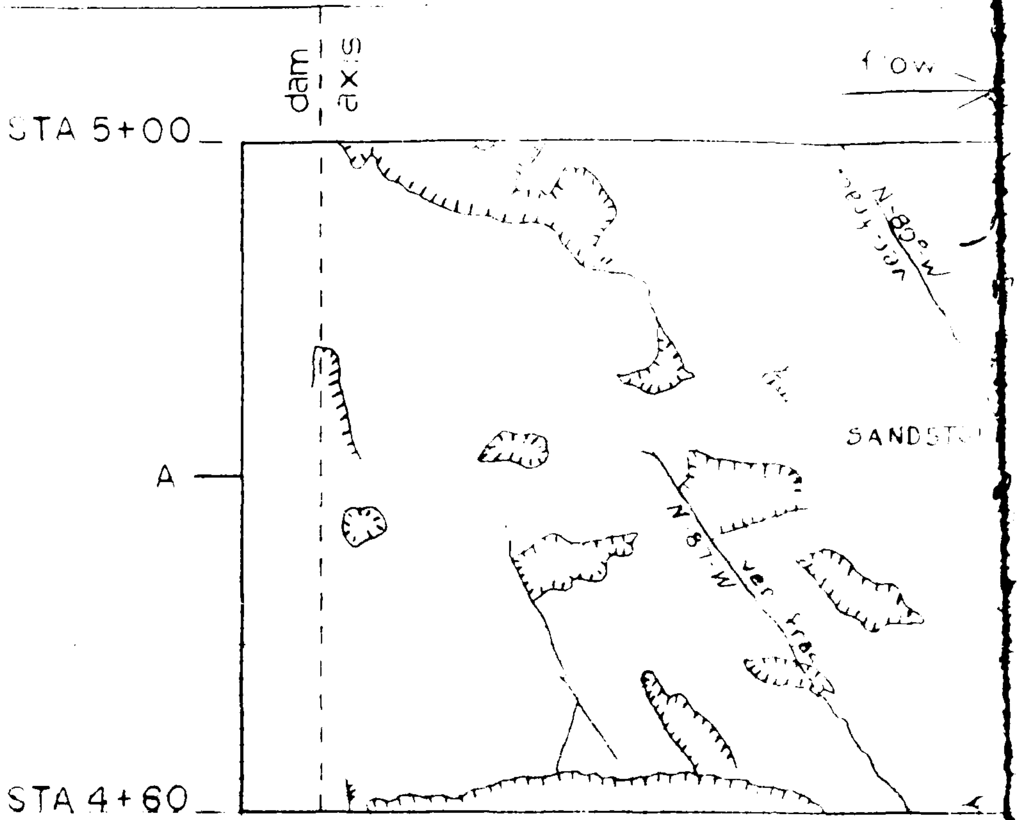
U.S. ARMY, HUNTINGTON DISTRICT
CORPS OF ENGINEERS

FOUNDATION REPORT
WEST FORK RIVER, WEST VIRGINIA
STONEWALL JACKSON DAM

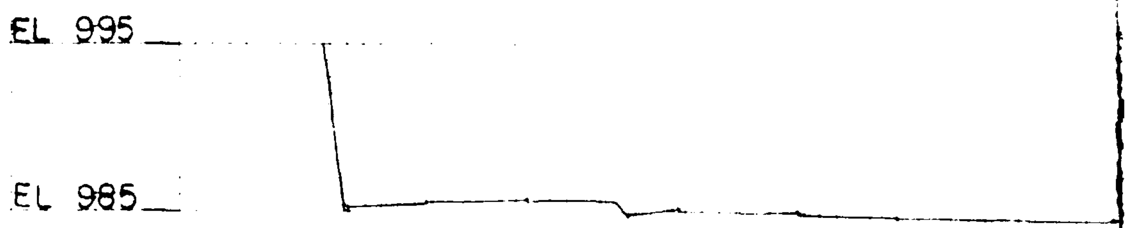
EXPLORATORY BORINGS
INSTRUMENTATION
PHOTOGRAPHS

Scale: 1" = 20' PLAN VIEW

EXHIBIT NO. 9-108

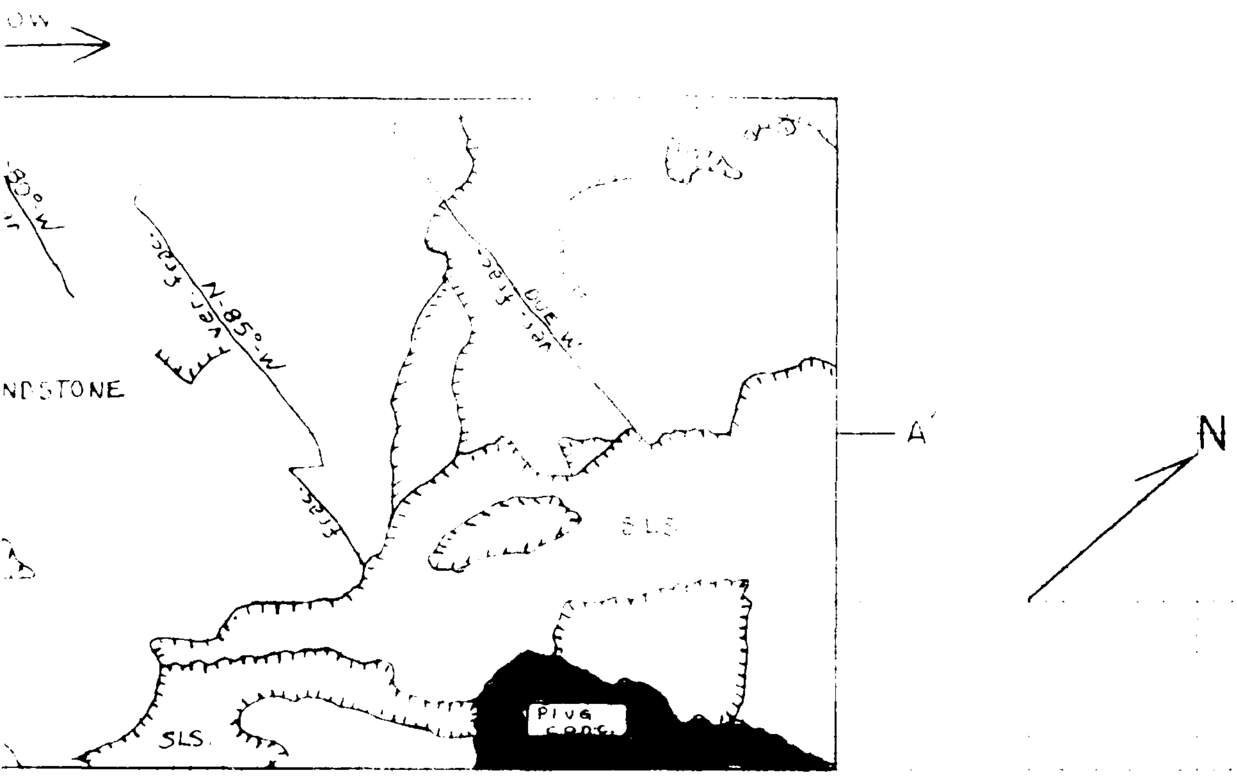


PLAN V

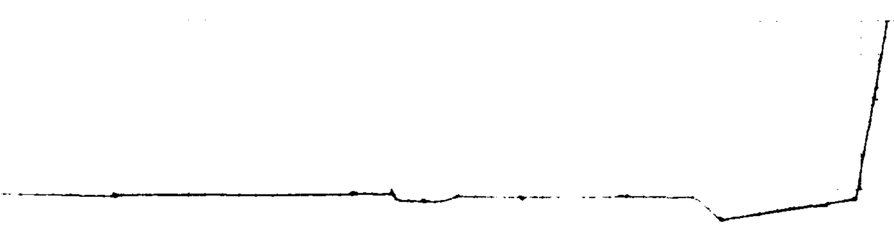


X – SECTI

A — A'



N VIEW



ECTION

A'

U.S. ARMY, HUNTINGTON DISTRICT
CORPS OF ENGINEERS

FOUNDATION REPORT

WEST FORK RIVER, WEST VIRGINIA

STONEWALL JACKSON DAM

FOUNDATION GEOLOGY
MONOLITH - 10

Scale: 1" = 10' PLAN VIEW

EXHIBIT NO. 9-10C

FOUNDATION GEOLOGY

MONOLITH NO. 11

LOCATION: Dam Monolith STATION: 5+00 to 5+4-

REFERENCE EXPLORATORY BORINGS:
(1) Pre-contract: 42, 59, 67, 102

(2) During Contract: 208

FOUNDATION:
(1) Elevation: 985.0

(2) Dimensions: Width 40' 0"; Length 88' 6-7/16"

(3) Description: Fine grained, silty sandstone

(4) Special or Unusual Conditions: Fault line in upstream right side area; extending into Monolith No. 12

(5) Treatment: 48 cubic yards of dental concrete placed in faulted area on 24 April 1985

(6) Dewatering: Dewatering pipe extended from water source in upstream face into Monolith No. 12 during first placement

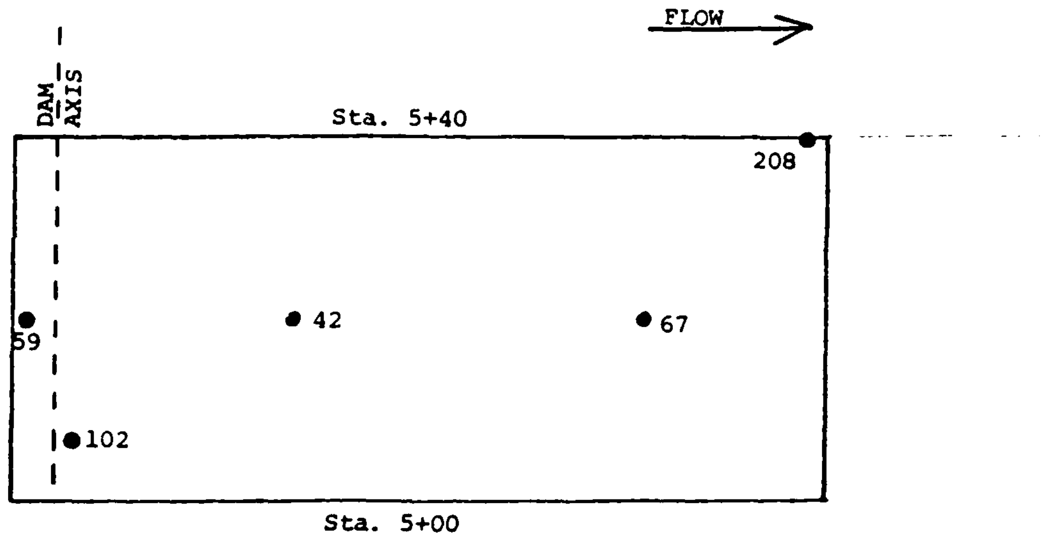
(7) Instrumentation: None

(8) Photographs: 189 to 194; 196 to 198
(See Volume II of this report)

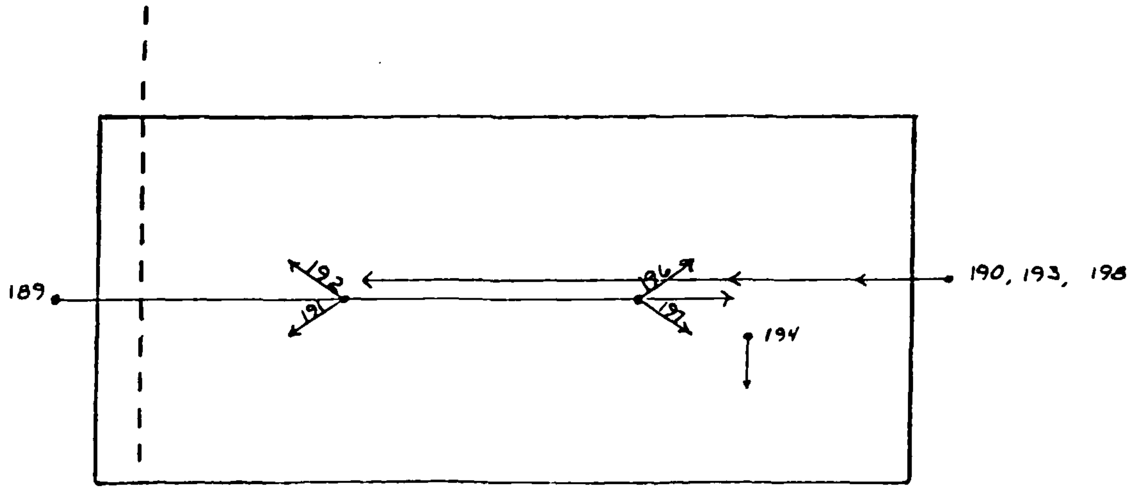
(9) First Placement: 01 May 1985

MONOLITH 11

FOUNDING ELEV. 985



EXPLORATORY BORINGS



PHOTOGRAPHS

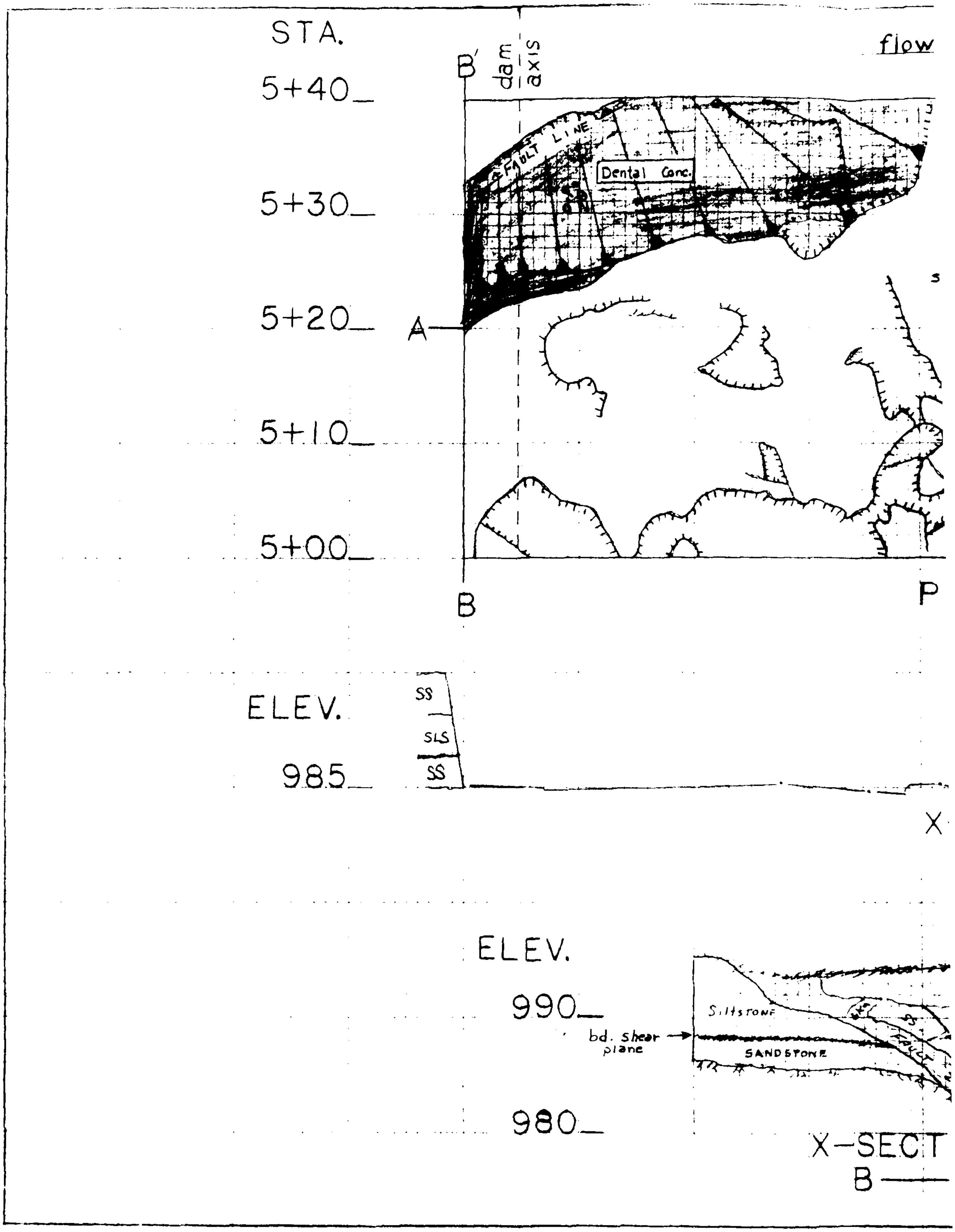
U.S. ARMY, HUNTINGTON DISTRICT
CORPS OF ENGINEERS

FOUNDATION REPORT
WEST FORK RIVER, WEST VIRGINIA
STONEWALL JACKSON DAM

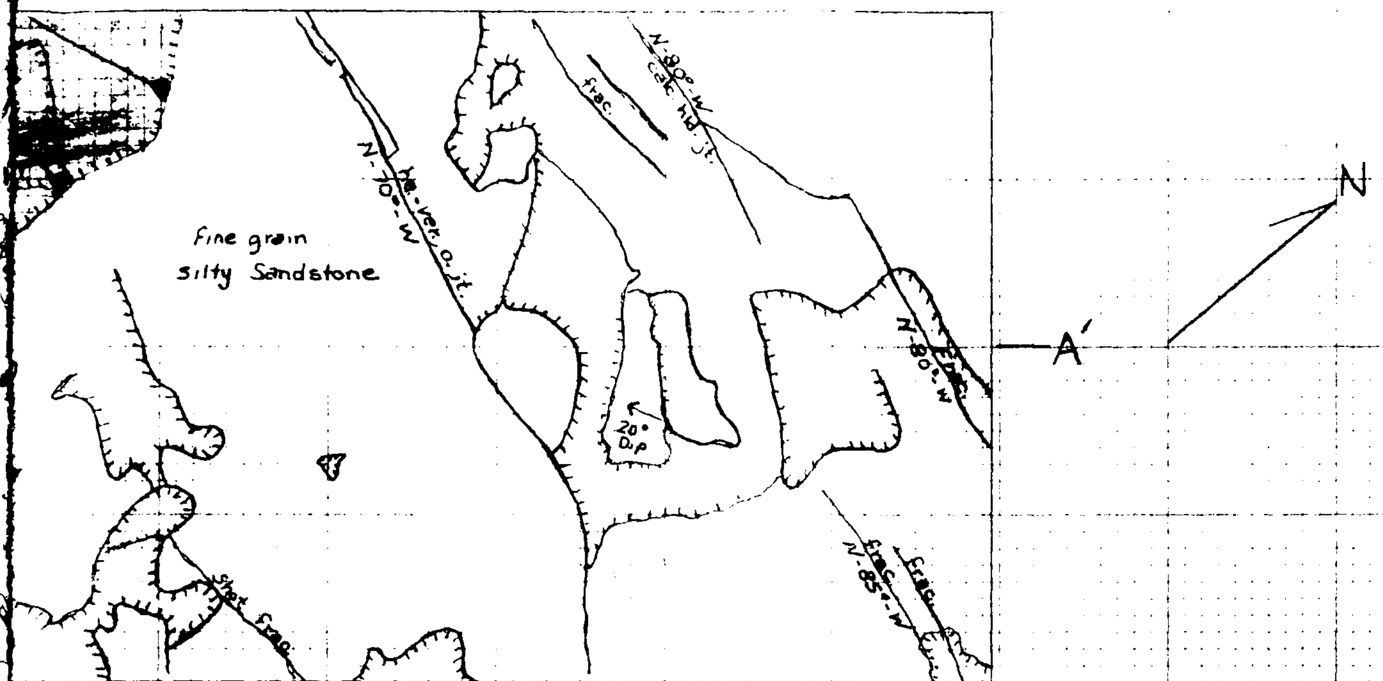
EXPLORATORY BORINGS
INSTRUMENTATION
PHOTOGRAPHS

Scale: 1" = 20' PLAN VIEW

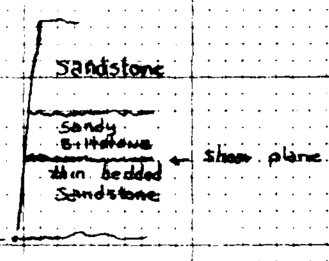
EXHIBIT NO. 9-11B


STA.
5+40
5+30
5+20
5+10
5+00
B'
dam axis
flow
FAULT LINE
Dental Conc.
A
B
P
ELEV.
SS
SLS
SS
985
X
ELEV.
990
980
bd. shear plane
Siltstone
SANDSTONE
X-SECT
B

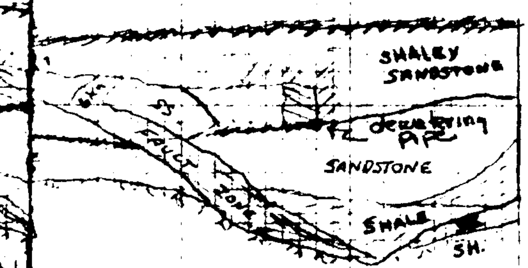
flow →



PLAN VIEW



X-SECTION
A —— A'



X-SECTION
B —— B'

U.S. ARMY, HUNTINGTON DISTRICT
CORPS OF ENGINEERS

FOUNDATION REPORT
WEST FORK RIVER, WEST VIRGINIA
STONEWALL JACKSON DAM

FOUNDATION GEOLOGY
MONOLITH - 11

Scale: 1" = 10' PLAN VIEW

EXHIBIT NO. 9-11C

FOUNDATION GEOLOGY

MONOLITH NO. 12

LOCATION: Dam Monolith STATION: 5+40 to 5+80

REFERENCE EXPLORATORY BORINGS:
(1) Pre-contract: 108, 109

(2) During Contract: 207, 218, 219, 222, 224, 225, 227, 228, 229, 230, 231

FOUNDATION:
(1) Elevation: 985

(2) Dimensions: Width 40′ 0″; Length 88′ 6-7/16″

(3) Description: Fractured, fine grained, silty sandstone and sandy siltstone

(4) Special or Unusual Conditions: Fault zone crossing monolith with associated open joint systems

(5) Treatment: Placed 92 cubic yards of dental concrete in faulted area on 17 May 1985

(6) Dewatering: Extensive dewatering system; see attached sheet

(7) Instrumentation: Uplift cells No. 13-18

(8) Photographs: 219 to 229
(See Volume II of this report)

(9) First Placement: 24 May 1985

U.S. ARMY, HUNTINGTON DISTRICT
CORPS OF ENGINEERS

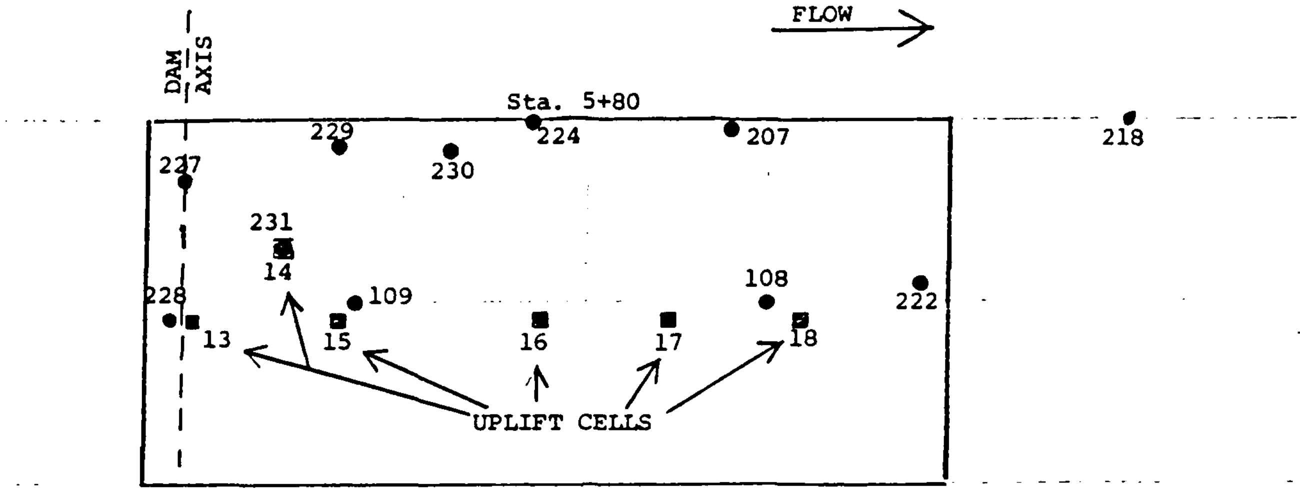
FOUNDATION REPORT
WEST FORK RIVER, WEST VIRGINIA
STONEWALL JACKSON DAM

STATISTICAL DATA
MONOLITH - 12

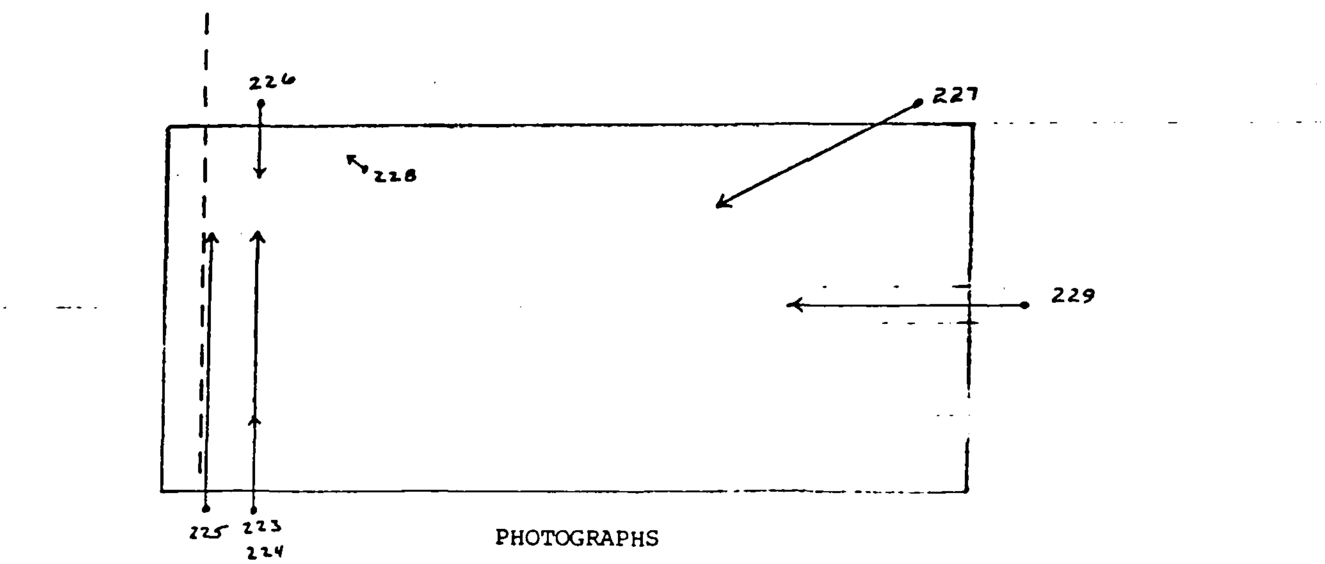
EXHIBIT NO. 9-12A

MONOLITH 12

FOUNDING ELEV. 985



EXPLORATORY BORINGS



PHOTOGRAPHS

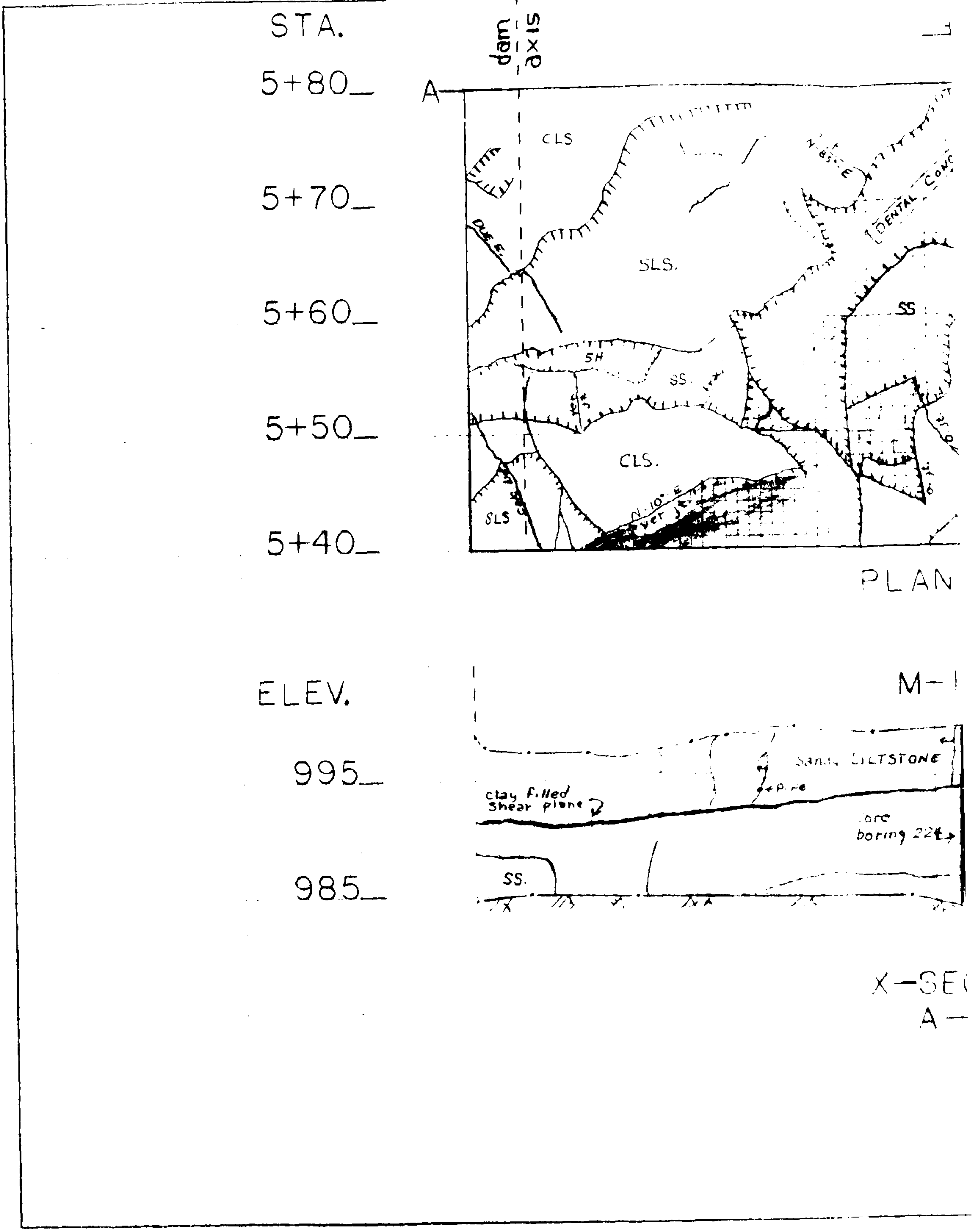
U.S. ARMY, HUNTINGTON DISTRICT
CORPS OF ENGINEERS

FOUNDATION REPORT
WEST FORK RIVER, WEST VIRGINIA
STONEWALL JACKSON DAM

EXPLORATORY BORINGS
INSTRUMENTATION
PHOTOGRAPHS

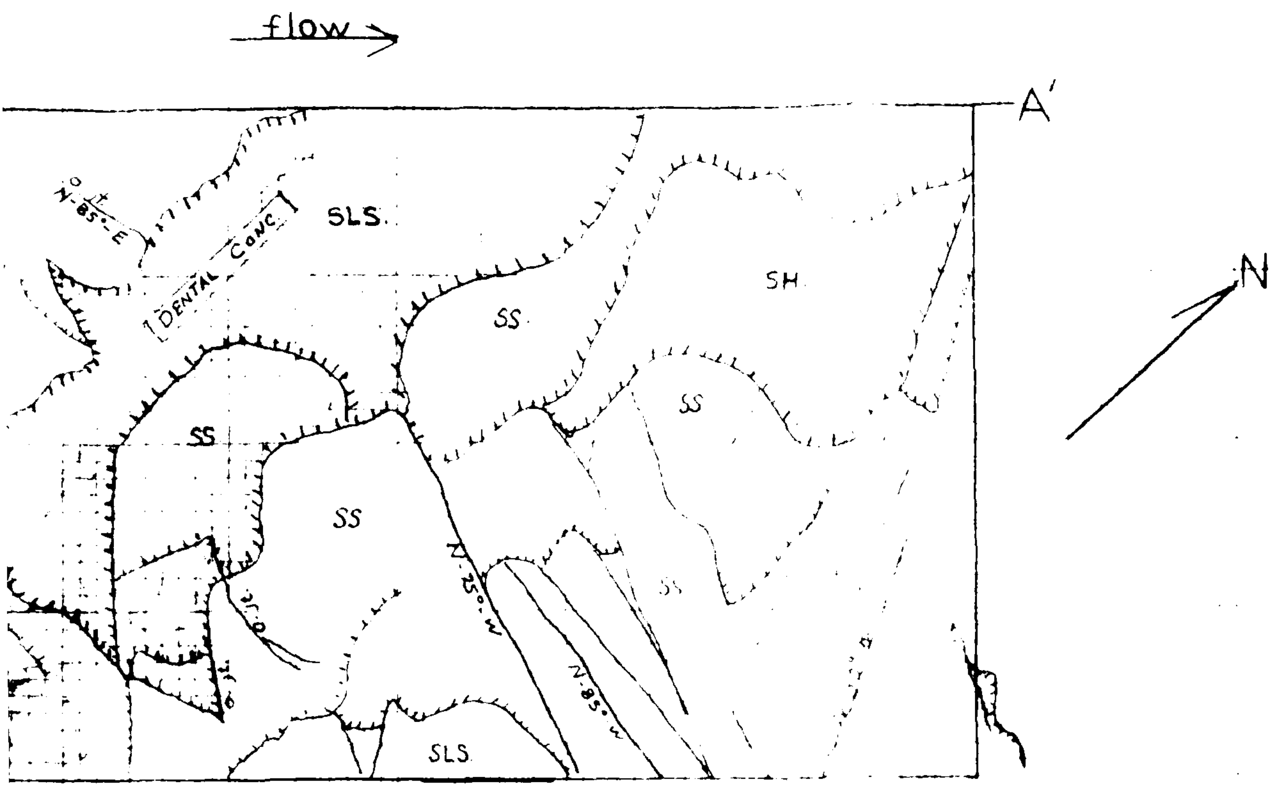
Scale: 1" = 20'   PLAN VIEW

EXHIBIT NO. 9-12B



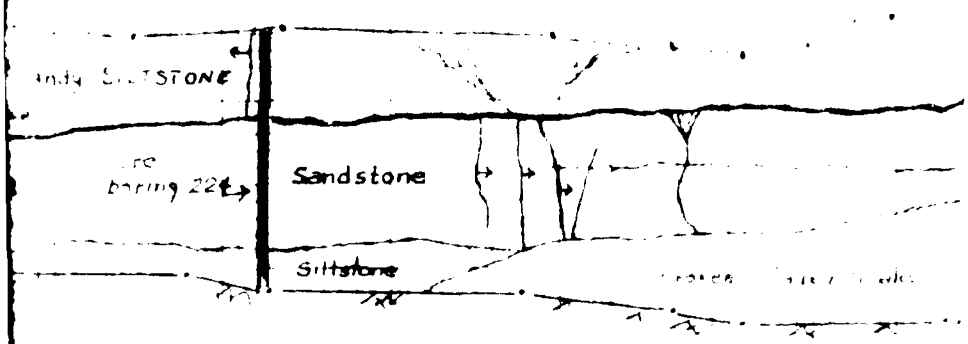
STA.
dam axis
5+80
A
5+70
5+60
5+50
5+40
CLS
SLS.
SH
SS.
CLS.
SLS
SS
DENTAL CONC
ELEV.
995
985
Sand. SILTSTONE
clay filled
Shear plane
pipe
boring 224
SS.

PLAN
M-
X-SEC
A-



PLAN VIEW

M-13



X-SECTION
A —— A'

U.S. ARMY, HUNTINGTON DISTRICT
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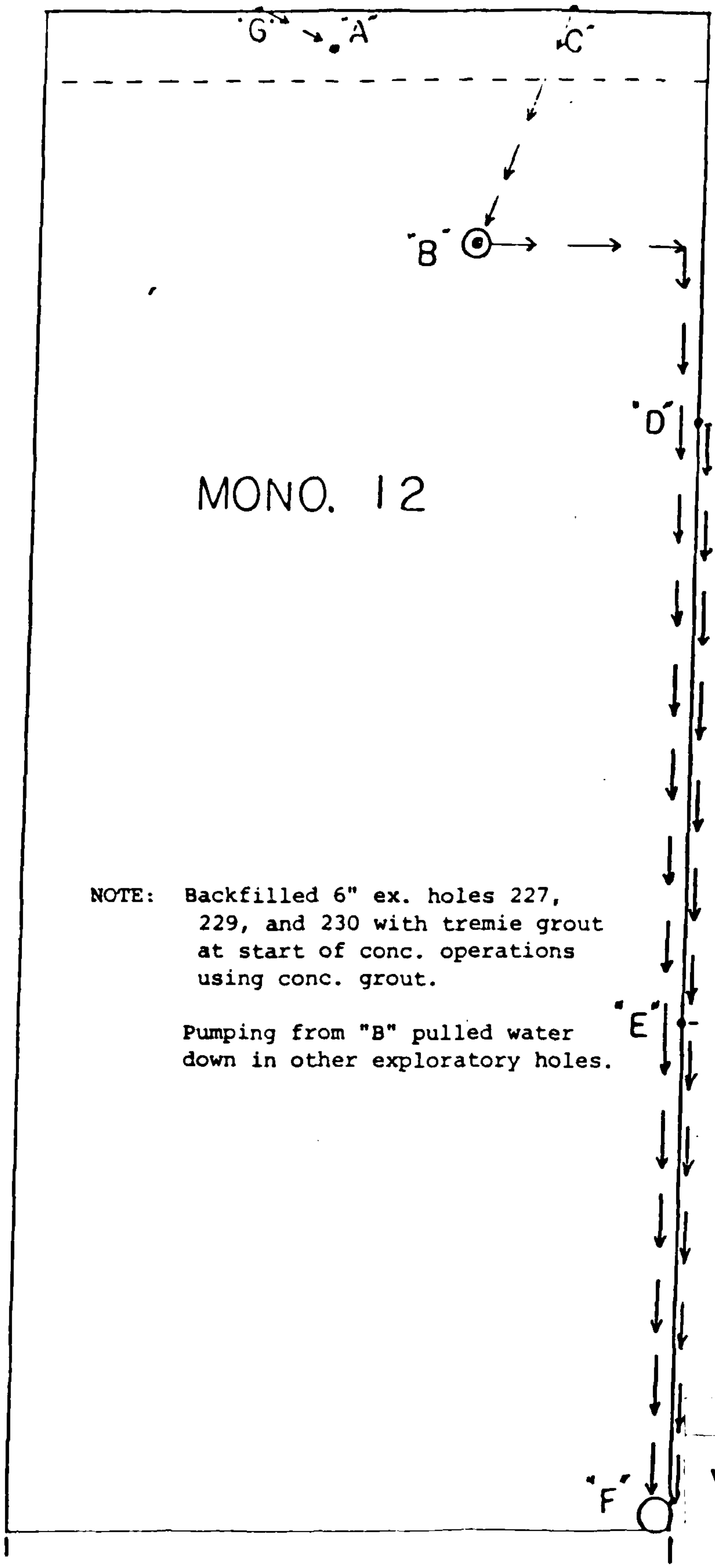
FOUNDATION REPORT
WEST FORK RIVER, WEST VIRGINIA
STONEWALL JACKSON DAM

FOUNDATION GEOLOGY
MONOLITH - 12

Scale: 1" = 10' PLAN VIEW

EXHIBIT NO. 9-12C



NOTE: Backfilled 6" ex. holes 227, 229, and 230 with tremie grout at start of conc. operations using conc. grout.

Pumping from "B" pulled water down in other exploratory holes.

A. 6" PVC pipe inserted into exp. hole 228: tremie grouted when conc. at elev. 1005.

B. 24" dia. CMP pipe grouted around exp. hole 231: pump water thru 4" PVC to main sump in d/s, lt. corner (F). Backfilled with 1¼ yds conc. when lift was at elev. 1000.

C. 6" dia. PVC pipe grouted into u/s face: bd. pn. water gravity fed to "B" CMP pipe for 1st lift. "T" at wall installed at elev. 990-ver. pipe ext. to elev. 1000, grouted at elev. 1000.

D. 4" dia. PVC pipe grouted into 12/13 face at water producing ha. jt.: gravity fed to main sump in d/s, lt. corner for 1st lift: tremie grouted 6-5-85.

E. 4" PVC pipe inserted by elbow under overhang for grouting: tremie grouted 6-5-85.

F. 24" CMP pipe set in d/s, lt. corner for hvy. flow thru rock (12/13 face) and feeder pipes. Water discharged to settling pond. See attached sheets.

G. 4" PVC pipe pip grouted into water producing bd. pn.; gravity fed to "A".

U.S. ARMY, HUNTINGTON DISTRICT
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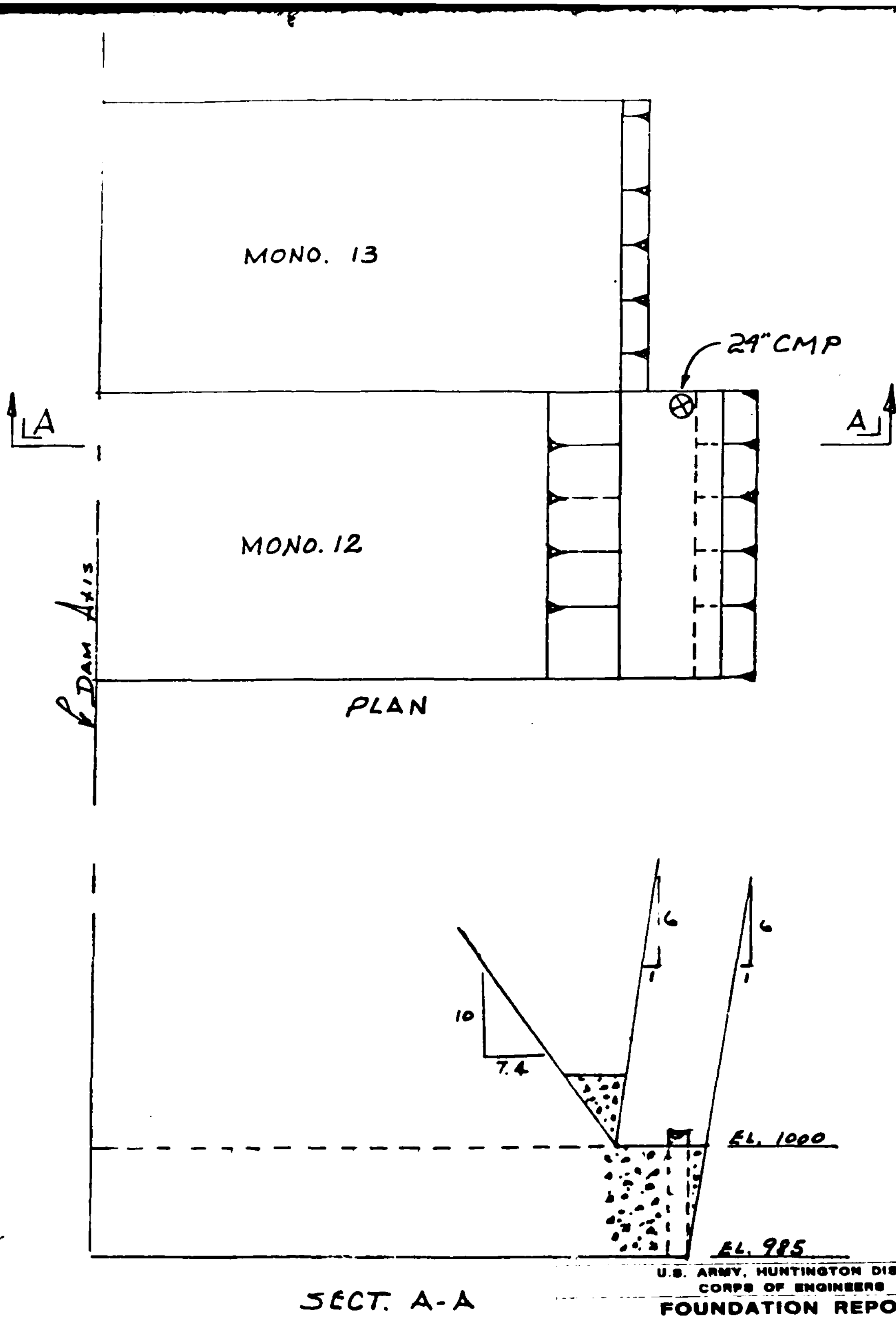
FOUNDATION REPORT
WEST FORK RIVER, WEST VIRGINIA
STONEWALL JACKSON DAM

MONOLITH 12 FOUNDATION DEWATERING PLAN

Scale: 1" = 20' PLAN VIEW

EXHIBIT NO. 9-12A1



U.S. ARMY, HUNTINGTON DISTRICT
CORPS OF ENGINEERS

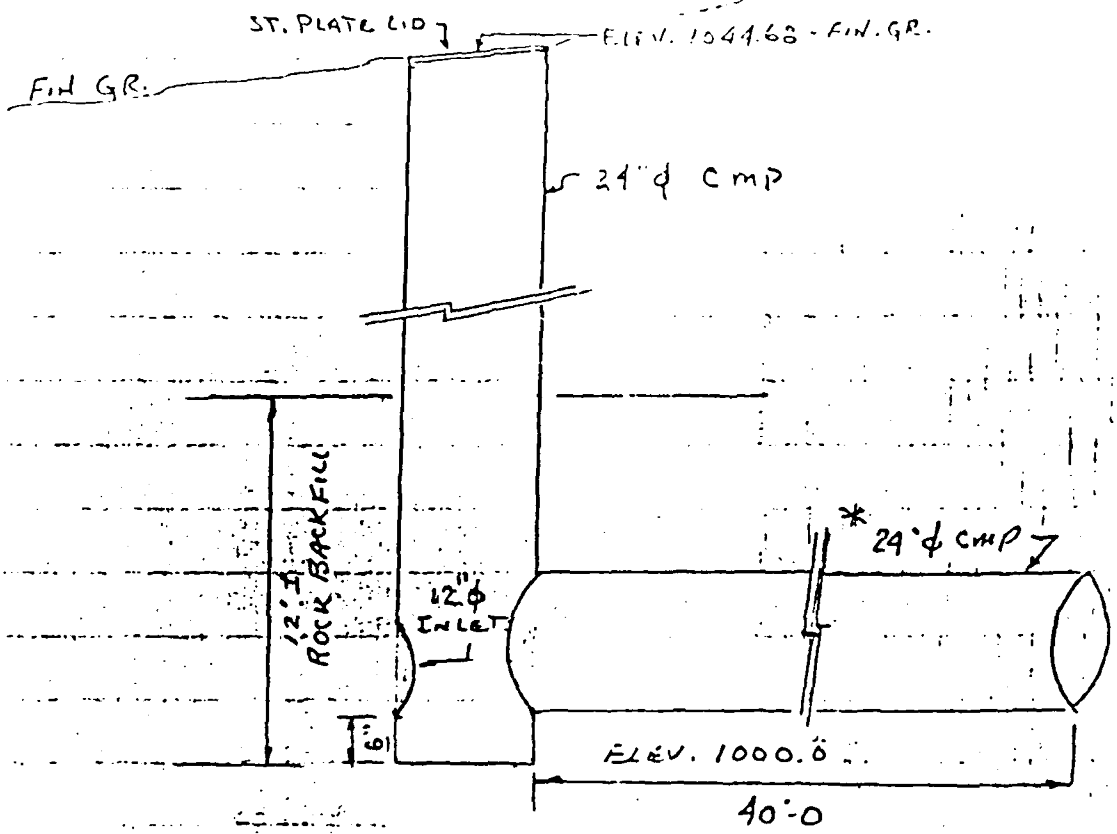
FOUNDATION REPORT
WEST FORK RIVER, WEST VIRGINIA
STONEWALL JACKSON DAM

MONOLITH 12 FOUNDATION DEWATERING PLAN

Scale: 1" = 20'   PLAN VIEW

SJLD WATER WELL LOCATION AND DEPTH [illegible]

LOCATION: 5+78 50 73.10 RT. OF AXIS



N.T.S.

ROCK BACKFILL 10'-15' WIDE PARALLEL TO AXIS OF DAM TO TRAINING WALL - PARALLEL FULL LENGTH OF TRAINING WALL TO SERVE AS OUTLET.

U.S. ARMY, HUNTINGTON DISTRICT
CORPS OF ENGINEERS

FOUNDATION REPORT
WEST FORK RIVER, WEST VIRGINIA
STONEWALL JACKSON DAM

MONOLITH 12 FOUNDATION
DEWATERING PLAN

Scale: 1" = 20' PLAN VIEW

EXHIBIT NO. 9-12A3

FOUNDATION GEOLOGY

MONOLITH NO. 13

LOCATION: Dam Monolith STATION: 5+80 to 6_20

REFERENCE EXPLORATORY BORINGS:
(1) Pre-contract: 110

(2) During Contract: 219, 223, 224, 225, 226

FOUNDATION:
(1) Elevation: 1000

(2) Dimensions: Width 40′ 0"; Length 76′ 8-1/4"

(3) Description: Fine grained, silty sandstone

(4) Special or Unusual Conditions: None

(5) Treatment: Standard final clean-up

(6) Dewatering: Standard small sump pumps used during concrete placement

(7) Instrumentation: None

(8) Photographs: 237 to 246
(See Volume II of this report)

(9) First Placement: 07 June 85

U.S. ARMY, HUNTINGTON DISTRICT
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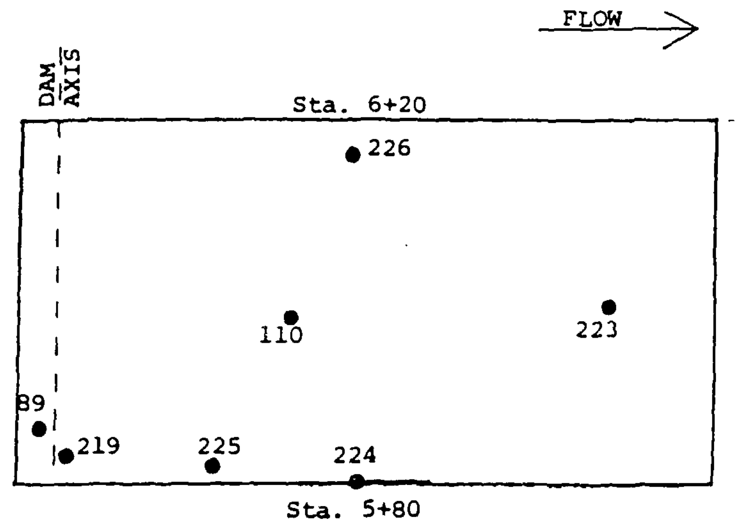
FOUNDATION REPORT
WEST FORK RIVER, WEST VIRGINIA
STONEWALL JACKSON DAM

STATISTICAL DATA
MONOLITH - 13

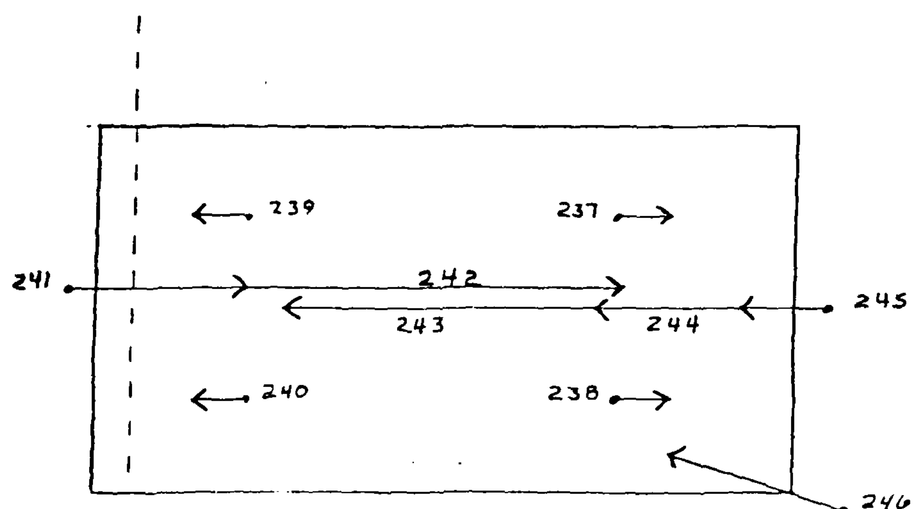
EXHIBIT NO. 9-13A

MONOLITH 13

FOUNDING ELEV. 1000



EXPLORATORY BORINGS



PHOTOGRAPHS

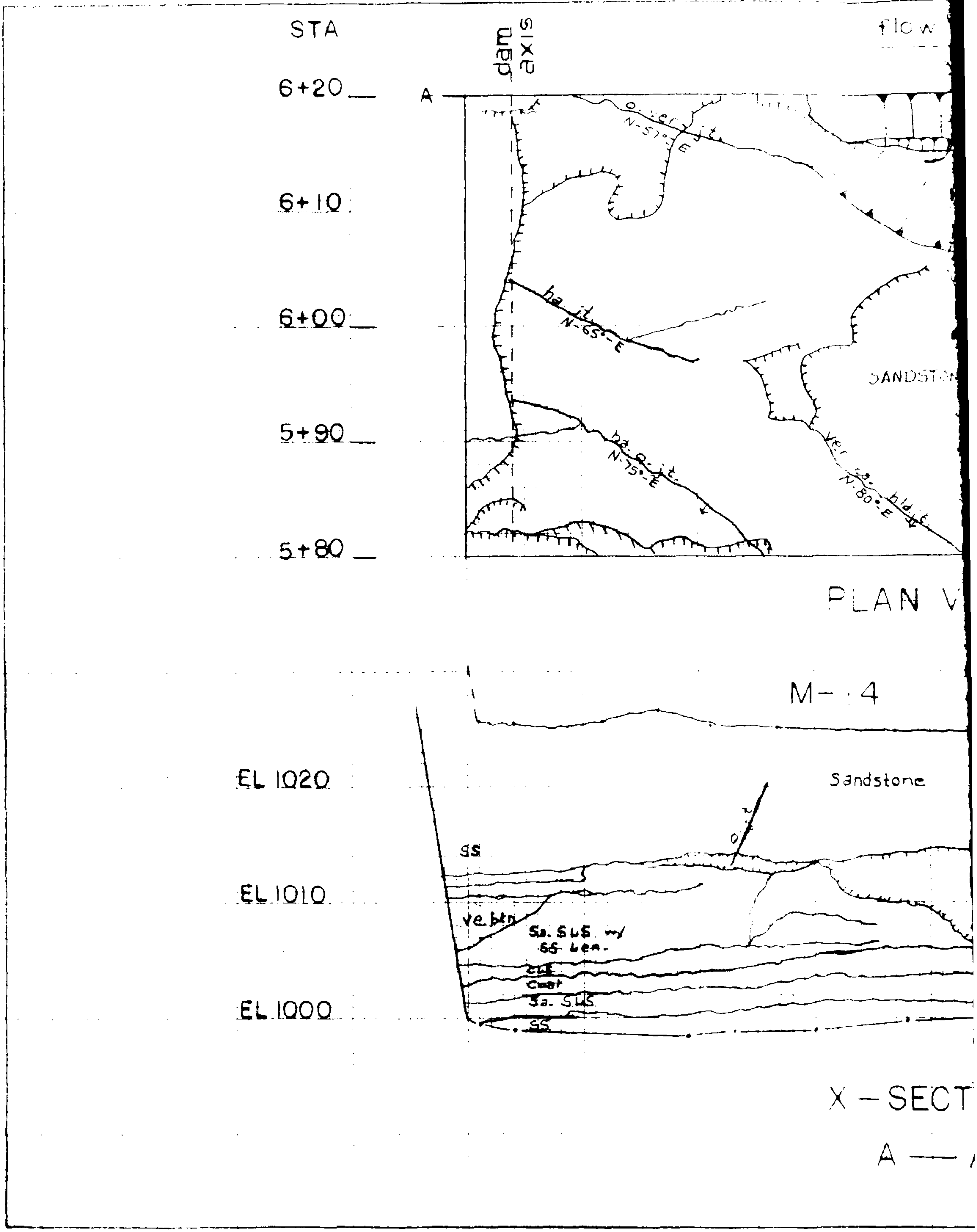
U.S. ARMY, HUNTINGTON DISTRICT
CORPS OF ENGINEERS

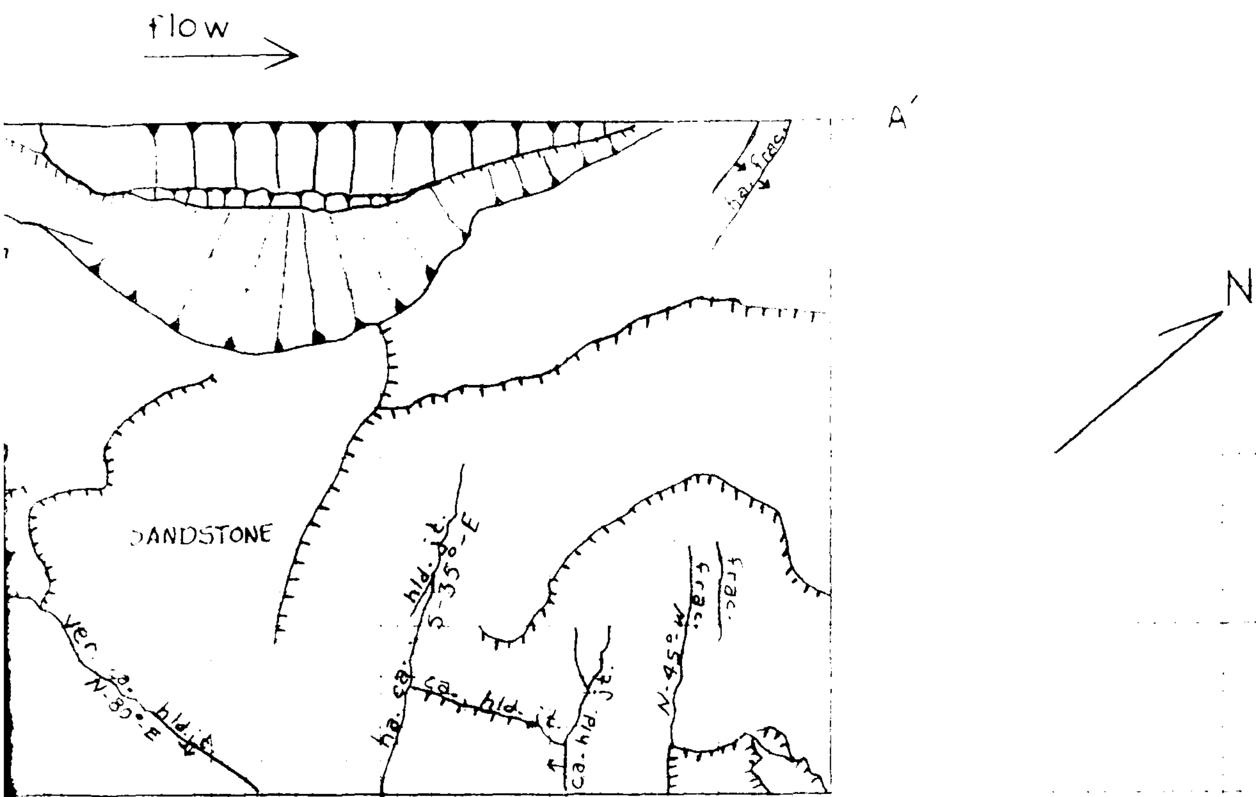
FOUNDATION REPORT
WEST FORK RIVER, WEST VIRGINIA
STONEWALL JACKSON DAM

EXPLORATORY BORINGS
INSTRUMENTATION
PHOTOGRAPHS

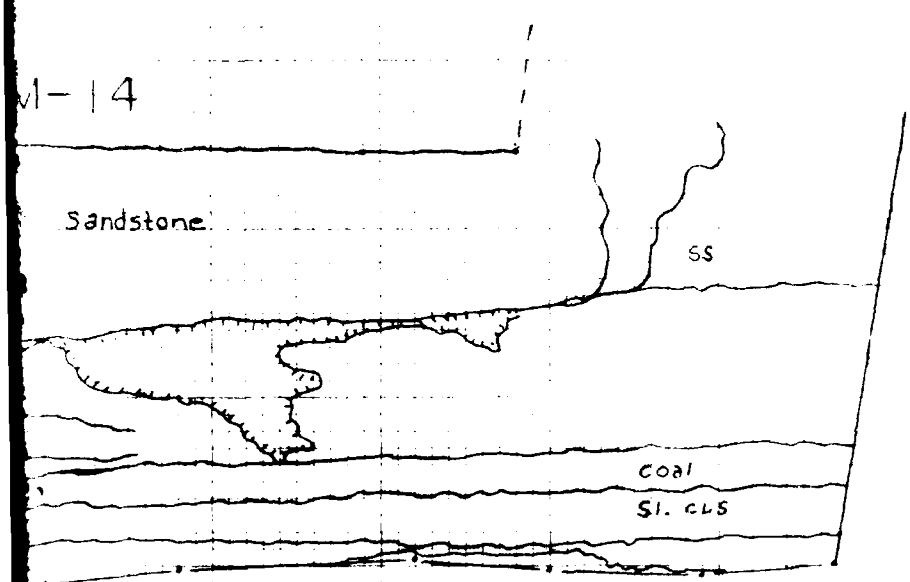
Scale: 1" = 20' PLAN VIEW

EXHIBIT NO. 9-13B


STA
dam axis
flow
6+20
6+10
6+00
5+90
5+80
A
N-65°-E
N-75°-E
N-80°-E
PLAN V
M-4
EL 1020
EL 1010
EL 1000
Sandstone
SS
Coal
SS
X-SECT
A — A



PLAN VIEW



X—SECTION

A — A´

U.S. ARMY, HUNTINGTON DISTRICT
CORPS OF ENGINEERS
FOUNDATION REPORT
WEST FORK RIVER, WEST VIRGINIA
STONEWALL JACKSON DAM

FOUNDATION GEOLOGY
MONOLITH - 13

Scale: 1" = 10' PLAN VIEW

EXHIBIT NO. 9-13C

FOUNDATION GEOLOGY

MONOLITH NO. 14

LOCATION: Dam Monolith STATION: 6+20 to 6+60

REFERENCE EXPLORATORY BORINGS:
(1) Pre-contract: 58A

(2) During Contract: 203, 206, 226

FOUNDATION:
(1) Elevation: 1027

(2) Dimensions: Width 40′ 0"; Length 55′ 4-1/4"

(3) Description: Fine grained, silty sandstone

(4) Special or Unusual Conditions: Several joints and fractures in foundation floor

(5) Treatment: Standard final clean-up

(6) Dewatering: Standard small sump pumps used during concrete placement

(7) Instrumentation: None

(8) Photographs: 254 to 263
(See Volume II of this report)

(9) First Placement: 11 July 1985

U.S. ARMY, HUNTINGTON DISTRICT
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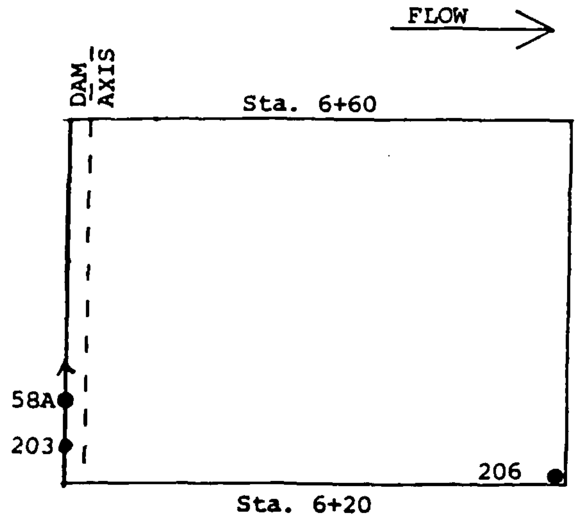
FOUNDATION REPORT
WEST FORK RIVER, WEST VIRGINIA
STONEWALL JACKSON DAM

STATISTICAL DATA
MONOLITH - 14

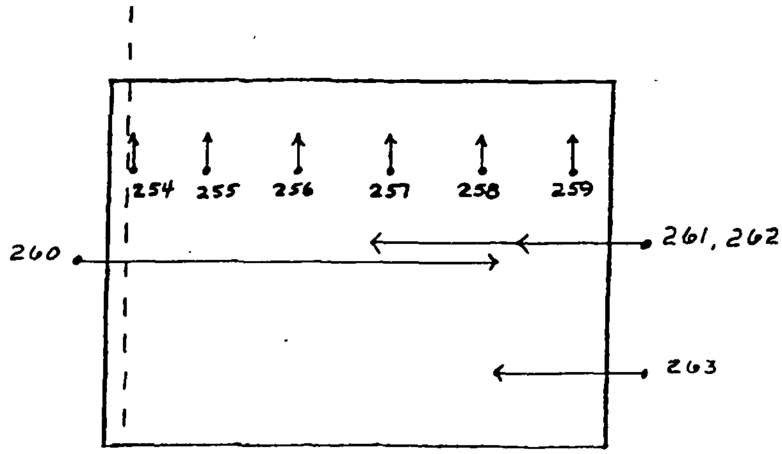
EXHIBIT NO. 9-14A

MONOLITH 14

FOUNDING ELEV. 1027



EXPLORATORY BORINGS



PHOTOGRAPHS

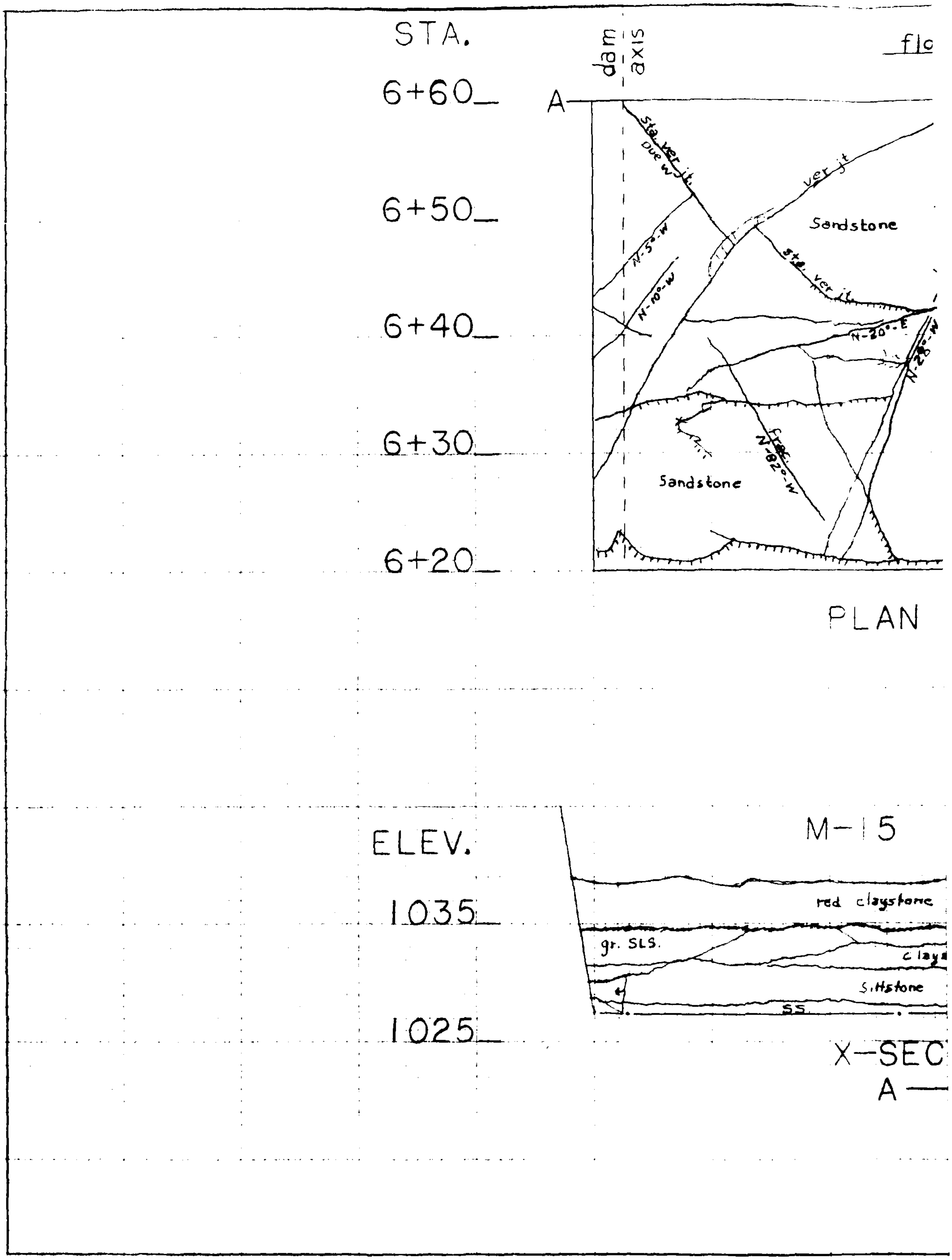
U.S. ARMY, HUNTINGTON DISTRICT
CORPS OF ENGINEERS

FOUNDATION REPORT
WEST FORK RIVER, WEST VIRGINIA
STONEWALL JACKSON DAM

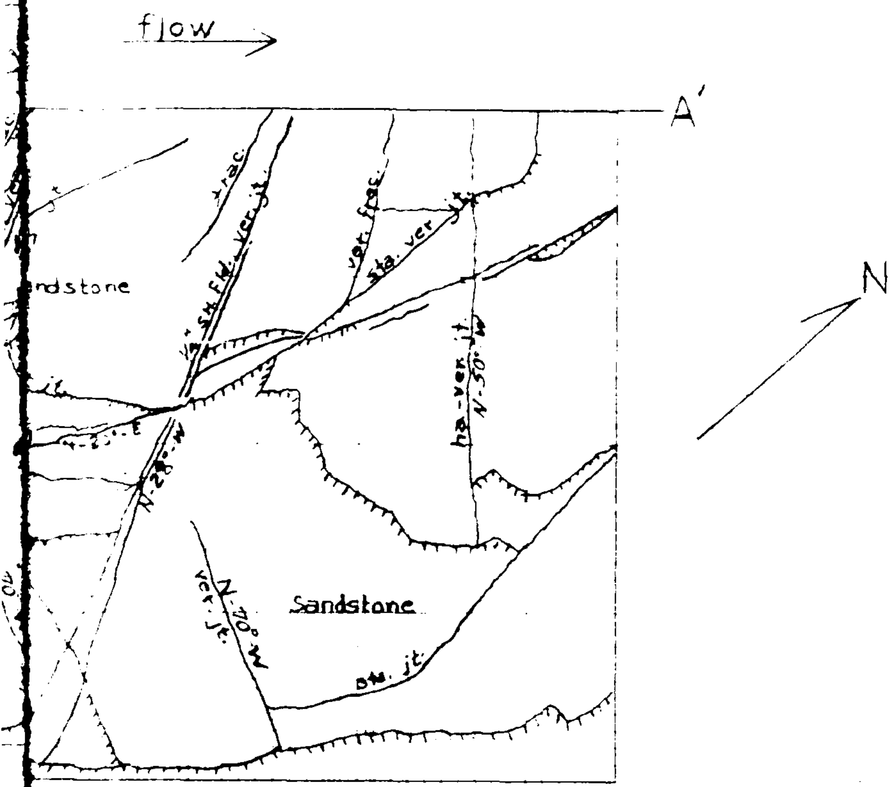
EXPLORATORY BORINGS
INSTRUMENTATION
PHOTOGRAPHS

Scale: 1" = 20' PLAN VIEW

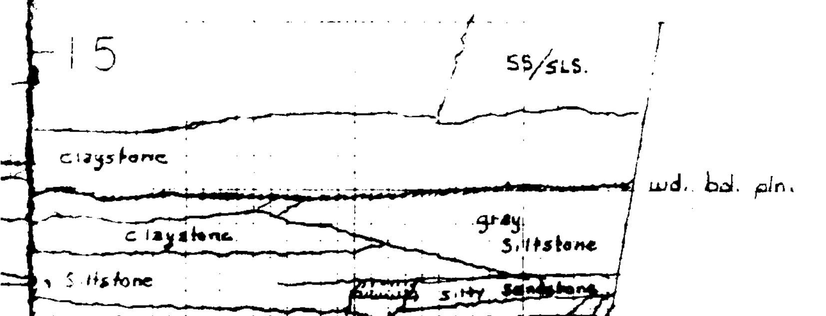
EXHIBIT NO. 9-14B



STA.
6+60
6+50
6+40
6+30
6+20
dam axis
A
sta. ver jt.
Due W jt.
ver jt
Sandstone
N-5°-W
N-10°-W
sta. ver jt.
N-20°-E
N-28°-W
Frac.
N-82°-W
Sandstone
PLAN
M-15
ELEV.
1035
1025
red claystone
gr. SLS.
Siltstone
SS
A



PLAN VIEW



-SECTION
A — A'

U.S. ARMY, HUNTINGTON DISTRICT
CORPS OF ENGINEERS

FOUNDATION REPORT
WEST FORK RIVER, WEST VIRGINIA
STONEWALL JACKSON DAM

FOUNDATION GEOLOGY
MONOLITH - 14

Scale: 1" = 10' PLAN VIEW

EXHIBIT NO. 9-14C

FOUNDATION GEOLOGY

MONOLITH NO. 15

LOCATION: Dam Monolith STATION: 6+60 to 7+00

REFERENCE EXPLORATORY BORINGS:

(1) Pre-contract: 47

(2) During Contract: 204

FOUNDATION:

(1) Elevation: 1040

(2) Dimensions: Width 40' 0"; Length 45' 1-1/16"

(3) Description: Reddish gray, occasionally sandy claystone

(4) Special or Unusual Conditions: None

(5) Treatment: Standard clean-up

(6) Dewatering: Standard small sump pumps used during concrete placement

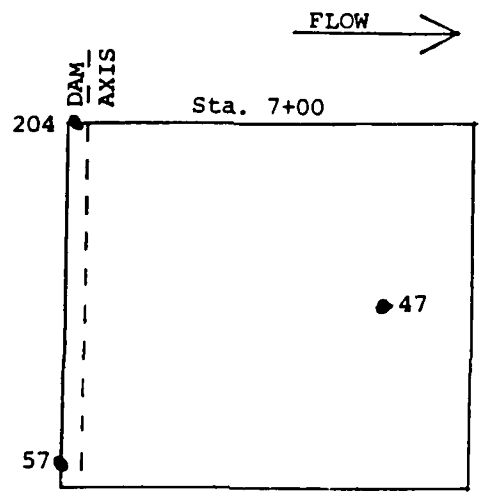
(7) Instrumentation: None

(8) Photographs: 269 to 274 (See Volume II of this report)

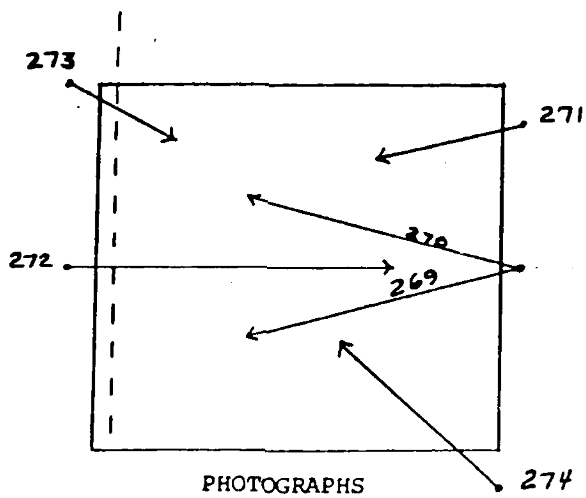
(9) First Placement: 19 July 1985

MONOLITH 15

FOUNDING ELEV. 1040



EXPLORATORY BORINGS



PHOTOGRAPHS

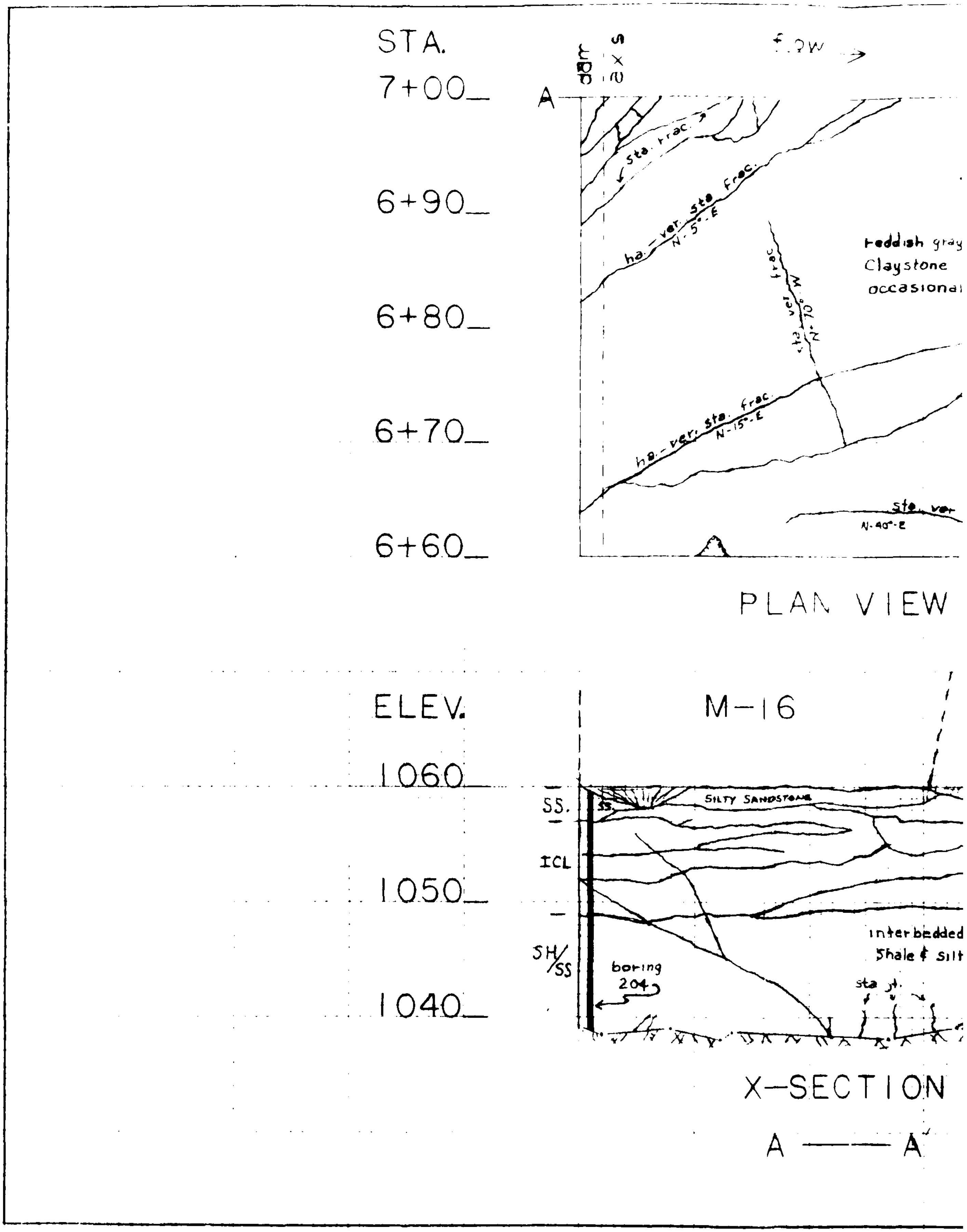
U.S. ARMY, HUNTINGTON DISTRICT
CORPS OF ENGINEERS

FOUNDATION REPORT
WEST FORK RIVER, WEST VIRGINIA
STONEWALL JACKSON DAM

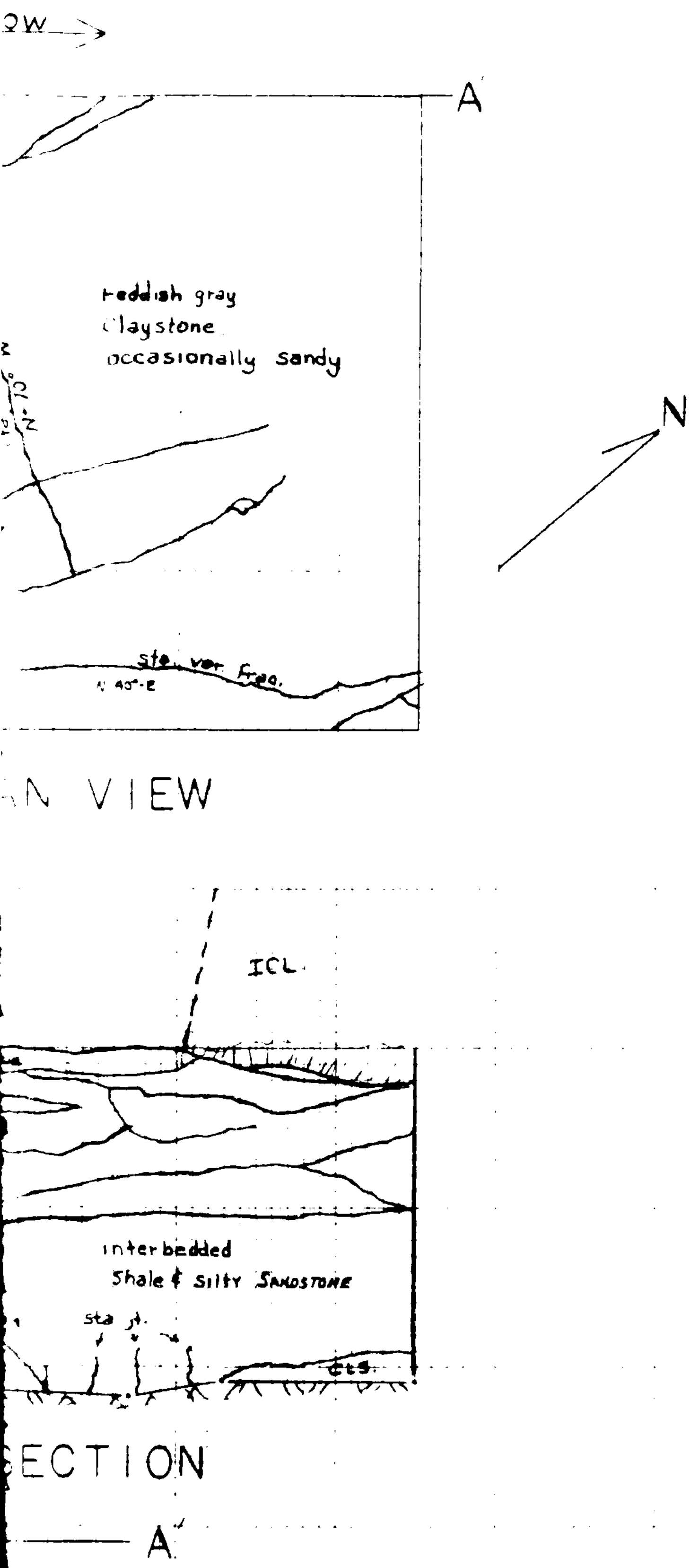
EXPLORATORY BORINGS
INSTRUMENTATION
PHOTOGRAPHS

Scale: 1" = 20'   PLAN VIEW

EXHIBIT NO. 9-15B



STA.
7+00
6+90
6+80
6+70
6+60
flow
A
sta. frac.
ha.-ver. sta. frac. N-5°-E
reddish gray Claystone occasional
sta ver frac N-70°-W
ha.-ver. sta. frac. N-15°-E
sta. ver N-40°-E
PLAN VIEW
ELEV.
M-16
1060
1050
1040
SS.
ICL
SH/SS
SILTY SANDSTONE
SS.
interbedded Shale & Silt
boring 204
sta jt.
X-SECTION
A —— A'



U.S. ARMY, HUNTINGTON DISTRICT
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FOUNDATION REPORT
WEST FORK RIVER, WEST VIRGINIA
STONEWALL JACKSON DAM

FOUNDATION GEOLOGY
MONOLITH - 15

Scale: 1" = 10' PLAN VIEW

EXHIBIT NO. 9-15C

FOUNDATION GEOLOGY

MONOLITH NO. 16

LOCATION: Dam Monolith STATION: 7+00 to 7+40

REFERENCE EXPLORATORY BORINGS:
- (1) Pre-contract: 56
- (2) During Contract: 205

FOUNDATION:
- (1) Elevation: 1060
- (2) Dimensions: Width 40' 0"; Length 29' 3-1/2"
- (3) Description: Fine grained, gray silty sandstone
- (4) Special or Unusual Conditions: Several north-northeast trending joints in foundation floor
- (5) Treatment: Standard clean-up: Brush grout open joints before concrete placement
- (6) Dewatering: Standard small sump pumps used during concrete placement
- (7) Instrumentation: None
- (8) Photographs: 275 to 296 (See Volume II of this report)
- (9) First Placement: 20 September 1985

U.S. ARMY, HUNTINGTON DISTRICT
CORPS OF ENGINEERS

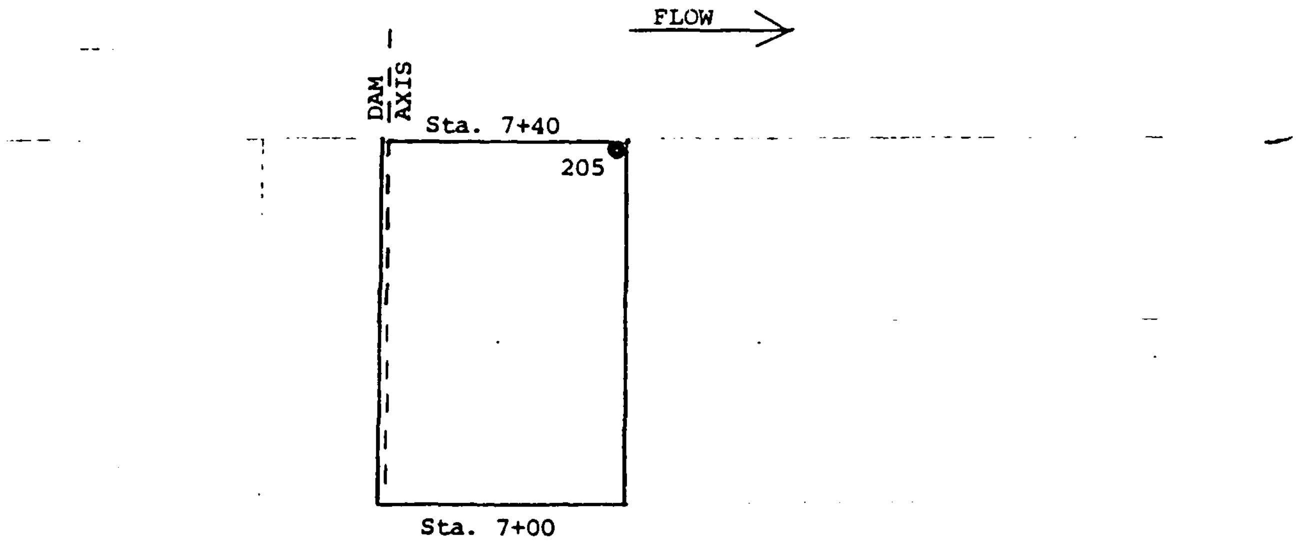
FOUNDATION REPORT
WEST FORK RIVER, WEST VIRGINIA
STONEWALL JACKSON DAM

STATISTICAL DATA
MONOLITH - 16

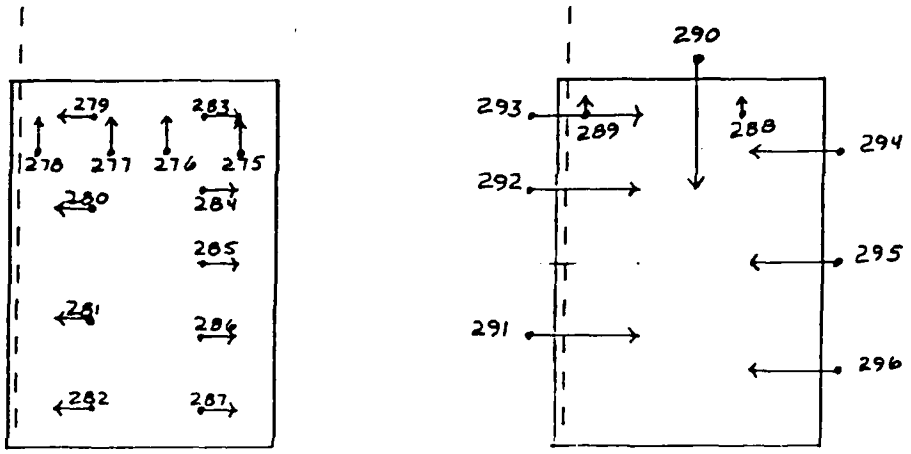
EXHIBIT NO. 9-16A

MONOLITH 16

FOUNDING ELEV. 1060



EXPLORATORY BORINGS



PHOTOGRAPHS

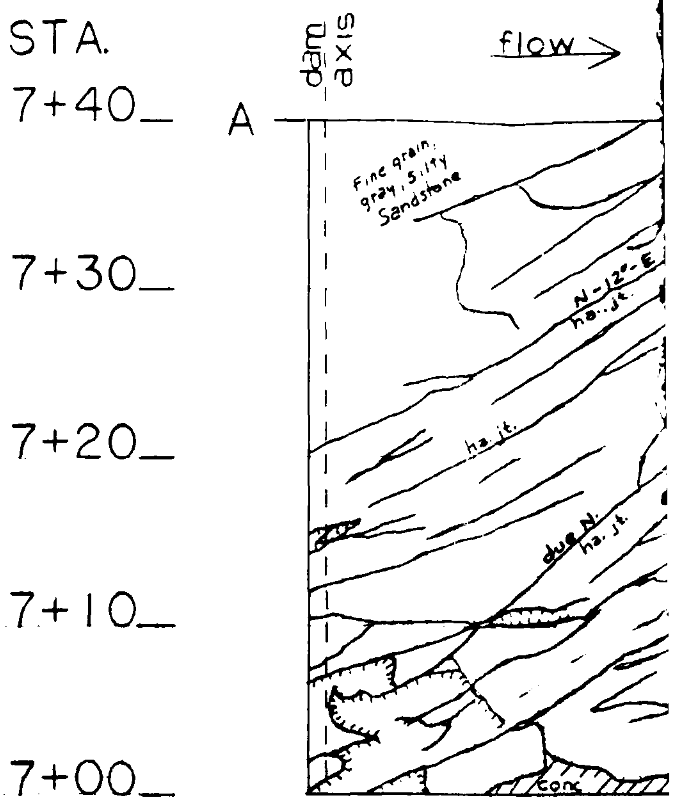
U.S. ARMY, HUNTINGTON DISTRICT
CORPS OF ENGINEERS

FOUNDATION REPORT
WEST FORK RIVER, WEST VIRGINIA
STONEWALL JACKSON DAM

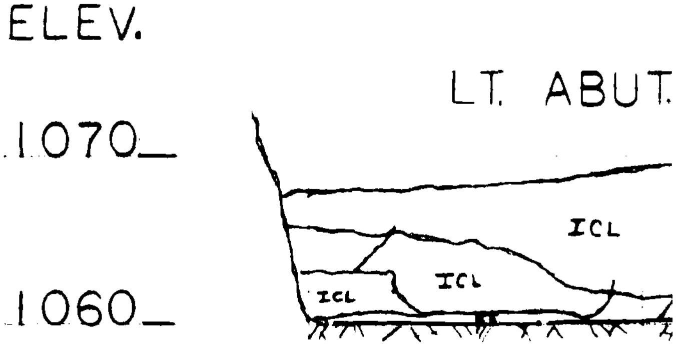
EXPLORATORY BORINGS
INSTRUMENTATION
PHOTOGRAPHS

Scale: 1" = 20'   PLAN VIEW

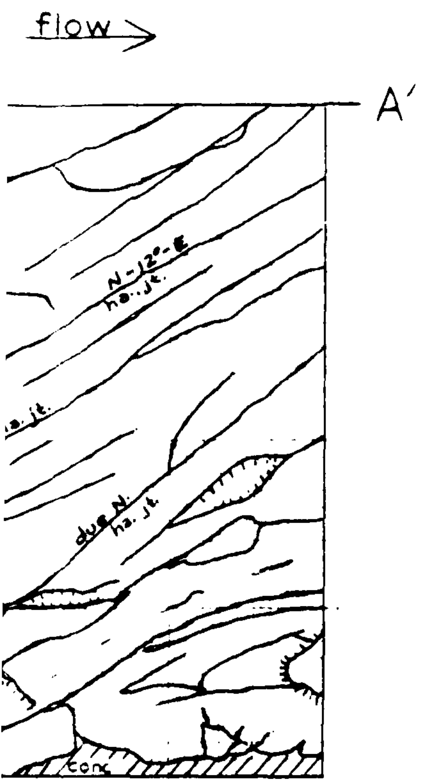
EXHIBIT NO. 9-16B



PLAN VIE

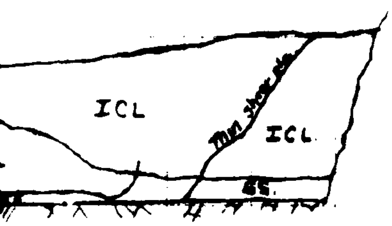


X—SECTIO
A — A'



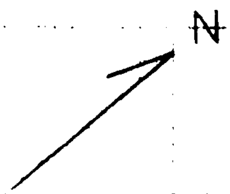
AN VIEW

T. ABUT.



SECTION

A — A'



U.S. ARMY, HUNTINGTON DISTRICT
CORPS OF ENGINEERS

FOUNDATION REPORT
WEST FORK RIVER, WEST VIRGINIA
STONEWALL JACKSON DAM

FOUNDATION GEOLOGY
MONOLITH - 16

Scale: 1" = 10' PLAN VIEW

EXHIBIT NO. 9-16C

FOUNDATION GEOLOGY

MONOLITH NOS. 17, 18, 19

LOCATION: Stilling Basin
Right Training Wall

STATION: 1+63.77 to 0+95.08N

REFERENCE EXPLORATORY BORINGS:
(1) Pre-contract: 96

(2) During Contract: None

FOUNDATION:
(1) Elevation: 998

(2) Dimensions: Width 20' 0"/26 0"; Length 68' 8"

(3) Description: Medium gray, sandy siltstone with dark cherty inclusions

(4) Special or Unusual Conditions: None

(5) Treatment: Standard final clean-up

(6) Dewatering: Standard small sump pumps used during concrete placement

(7) Instrumentation: None

(8) Photographs: 132, 133, 137 to 141
(See Volume II of this report)

(9) First Placement:

Monolith 17	09 December 1984
Monolith 18	06 November 1984
Monolith 19	01 November 1984

U.S. ARMY, HUNTINGTON DISTRICT
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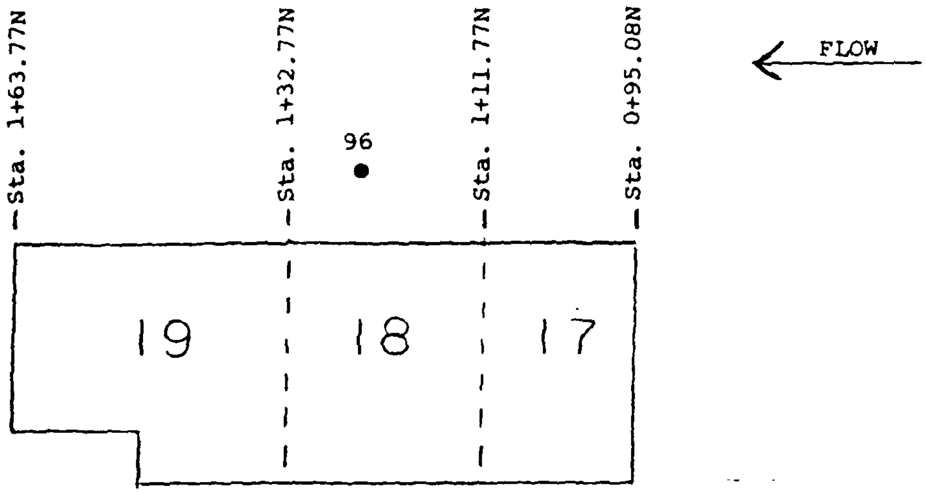
FOUNDATION REPORT
WEST FORK RIVER, WEST VIRGINIA
STONEWALL JACKSON DAM

STATISTICAL DATA
MONOLITHS 17, 18, 19

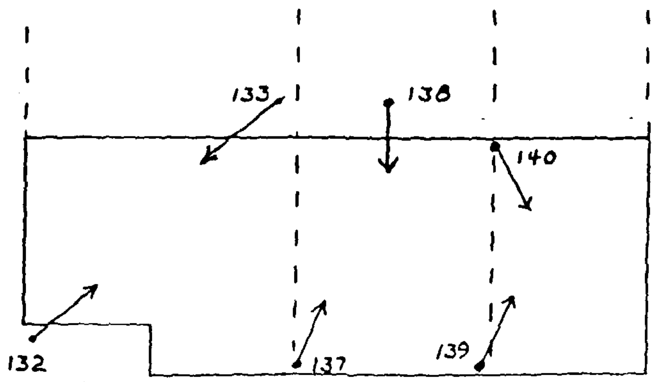
EXHIBIT NO. 9-17A

MONOLITHS 17,18,19

FOUNDING ELEV. 998



EXPLORATORY BORINGS



PHOTOGRAPHS

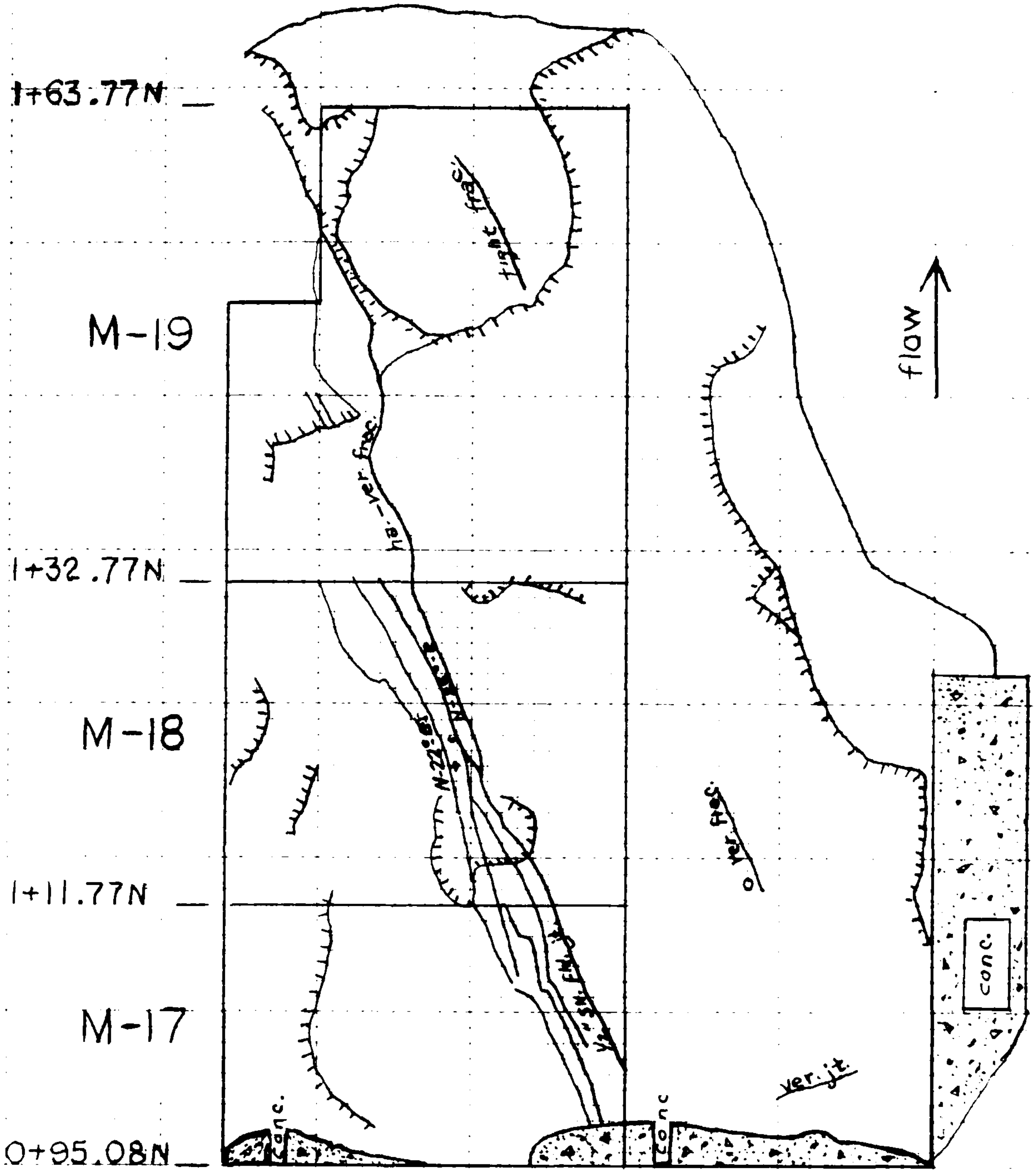
U.S. ARMY, HUNTINGTON DISTRICT
CORPS OF ENGINEERS

FOUNDATION REPORT
WEST FORK RIVER, WEST VIRGINIA
STONEWALL JACKSON DAM

EXPLORATORY BORINGS
INSTRUMENTATION
PHOTOGRAPHS

Scale: 1" = 20' PLAN VIEW

EXHIBIT NO. 9-17B



U.S. ARMY, HUNTINGTON DISTRICT
CORPS OF ENGINEERS

FOUNDATION REPORT

WEST FORK RIVER, WEST VIRGINIA

STONEWALL JACKSON DAM

FOUNDATION GEOLOGY
MONOLITH 17, 18, 19
RIGHT TRAINING WALL

Scale: 1" = 10'   PLAN VIEW

EXHIBIT NO. 9-17C

FOUNDATION GEOLOGY

MONOLITH NOS. 20, 21, 22 & BAFFEL SECTION

LOCATION: Stilling Basin Left Training Wall   STATION: 0+95.77N to 1+74.77N

REFERENCE EXPLORATORY BORINGS:
(1) Pre-contract: 76, 95

(2) During Contract: None

FOUNDATION:
(1) Elevation: 998

(2) Dimensions: Width 20' 0"/26' 0"; Length 79' 0"

(3) Description: Fine grained, silty sandstone and sandy shale with cherty inclusions

(4) Special or Unusual Conditions: None

(5) Treatment: Standard final clean-up

(6) Dewatering: Standard small sump pumps used during concrete placement

(7) Instrumentation: None

(8) Photographs: 30, 31, 39 to 41, 88, 89 (See Volume II of this report)

(9) First Placement:

Monolith 20	27 July 1984
Monolith 21	15 June 1984
Monolith 22	08 June 1984
Baffel Section	20 June 1984

U.S. ARMY, HUNTINGTON DISTRICT
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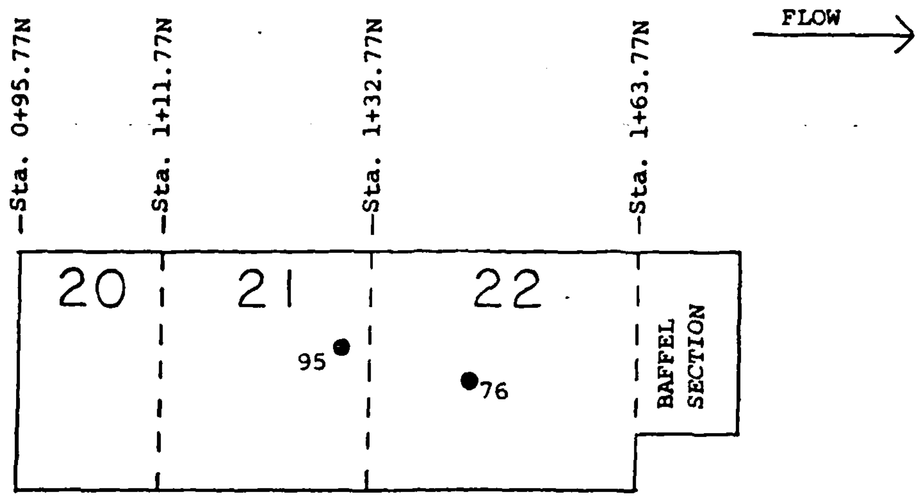
WEST FORK RIVER, WEST VIRGINIA
STONEWALL JACKSON DAM

STATISTICAL DATA
MONOLITHS 20, 21, 22

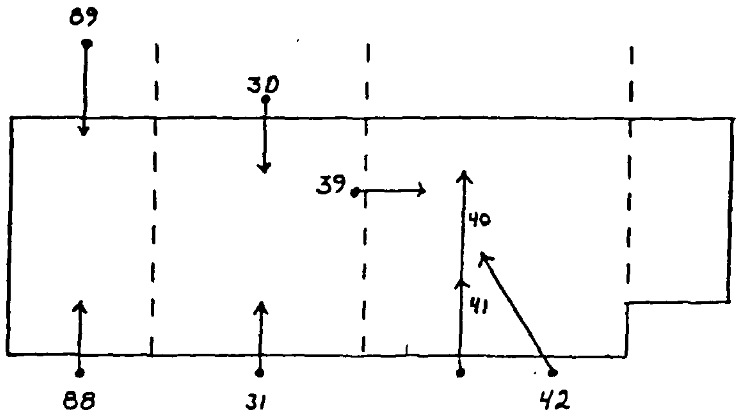
EXHIBIT NO. 9-18A

MONOLITHS 20, 21, 22 AND BAFFEL SECTION

FOUNDING ELEV. 998



EXPLORATORY BORINGS



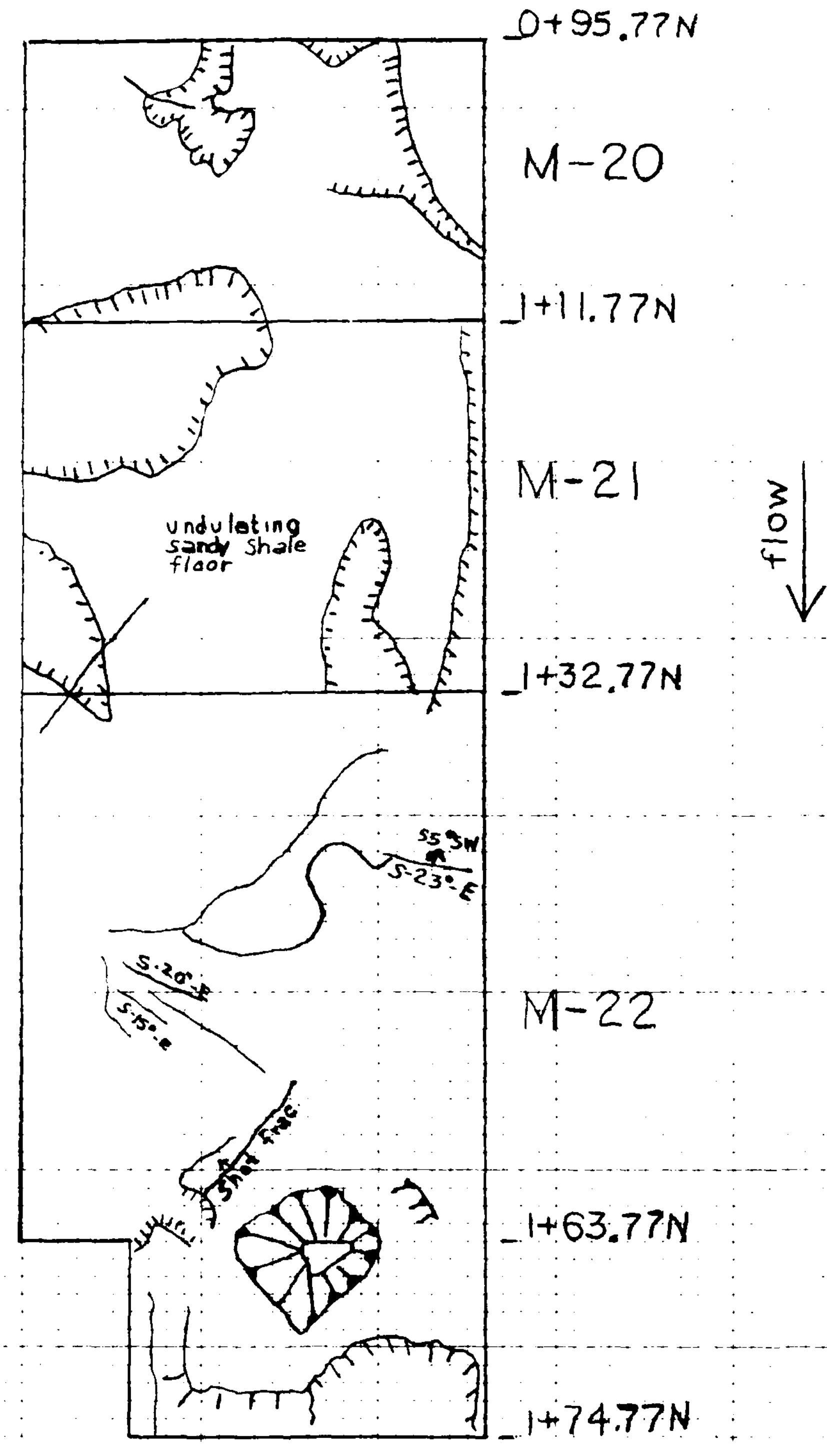
PHOTOGRAPHS

U.S. ARMY, HUNTINGTON DISTRICT
CORPS OF ENGINEERS
FOUNDATION REPORT
WEST FORK RIVER, WEST VIRGINIA
STONEWALL JACKSON DAM

EXPLORATORY BORINGS
INSTRUMENTATION
PHOTOGRAPHS

Scale: 1" = 20' PLAN VIEW

EXHIBIT NO. [illegible]



U.S. ARMY, HUNTINGTON DISTRICT
CORPS OF ENGINEERS

FOUNDATION REPORT
WEST FORK RIVER, WEST VIRGINIA
STONEWALL JACKSON DAM

FOUNDATION GEOLOGY
MONOLITH 20, 21, 22
LEFT TRAINING WALL

Scale: 1" = 10'   PLAN VIEW

EXHIBIT NO. 9-18C

FOUNDATION GEOLOGY

MONOLITH NO. 1A - 5C

LOCATION: Stilling Basin STATION: 3+10 to 4+15

REFERENCE EXPLORATORY BORINGS:
(1) Pre-contract: 86, 87, 113A, 112A

(2) During Contract: 211, 220, 221

FOUNDATION:
(1) Elevation: 998

(2) Dimensions: Width 105' 0"; Length 58' 0"/61' 6"

(3) Description: Medium gray, sandy siltstone with dark cherty inclusions

(4) Special or Unusual Conditions: Install anchor rods and drain hole pipe before concrete placement

(5) Treatment: Standard final clean-up

(6) Dewatering: Standard small sump pumps used during concrete placement

(7) Instrumentation: None

(8) Photographs: 109, 110, 129, 130, 131, 134, 135, 141-156, 159-162
(See Volume II of this report)

(9) First Placement:

	1	2	3	4	5
A	10-15-84	10-24-84	11-14-84	11-27-84	12-05-84
B	10-17-84	10-29-84	11-19-84	11-29-84	12-10-84
C	11-05-84	11-13-84	12-11-84	12-20-84	12-17-84

U.S. ARMY, HUNTINGTON DISTRICT
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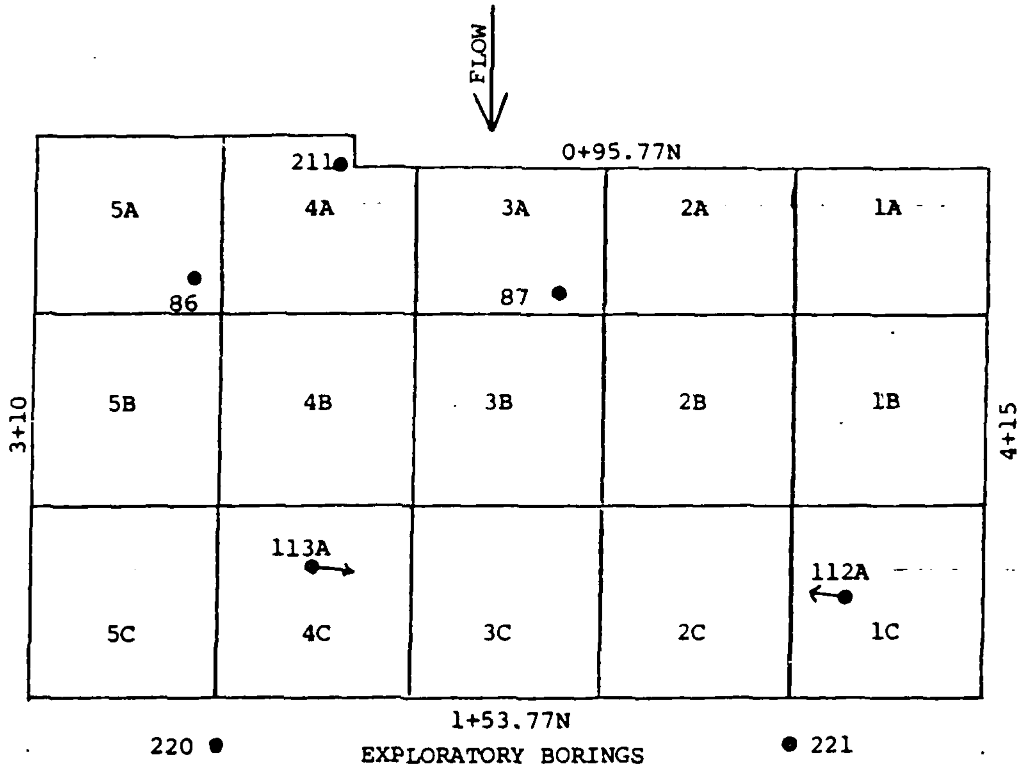
FOUNDATION REPORT
WEST FORK RIVER, WEST VIRGINIA
STONEWALL JACKSON DAM

STATISTICAL DATA
STILLING BASIN

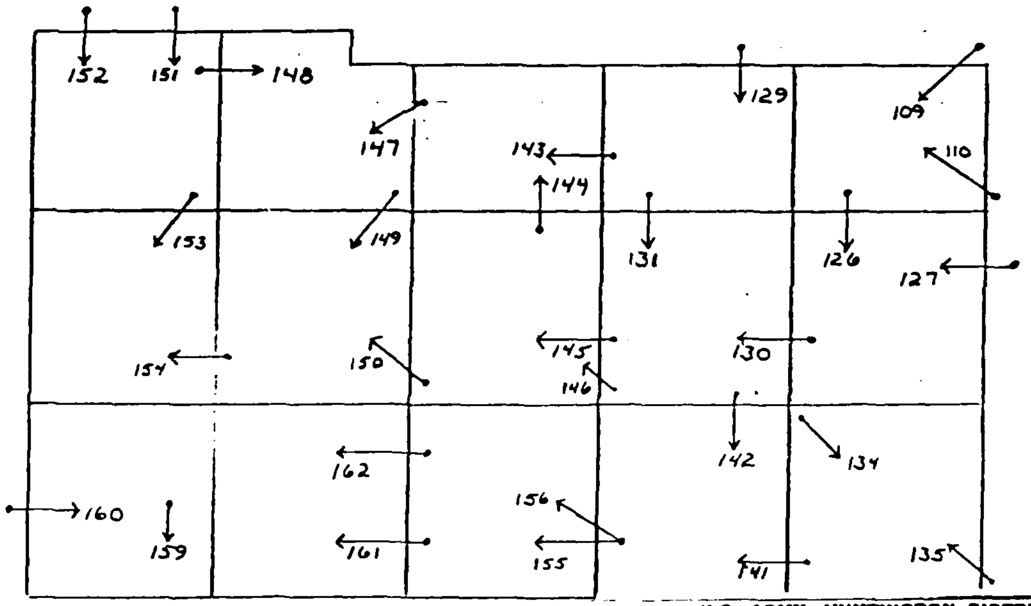
EXHIBIT NO. 9-19A

STILLING BASIN

FOUNDING ELEV. 998.0



EXPLORATORY BORINGS



PHOTOGRAPHS

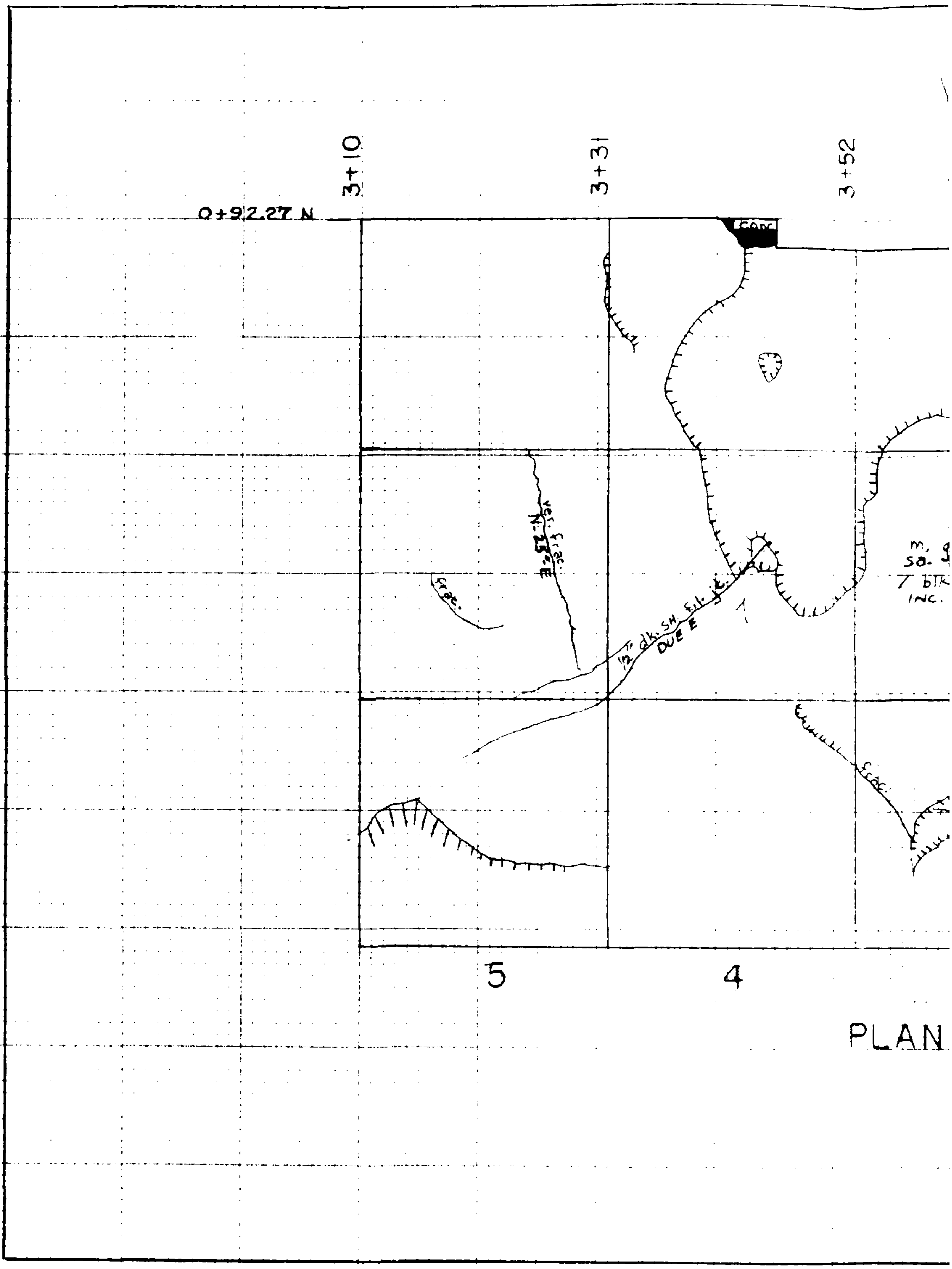
U.S. ARMY, HUNTINGTON DISTRICT
CORPS OF ENGINEERS

FOUNDATION REPORT
WEST FORK RIVER, WEST VIRGINIA
STONEWALL JACKSON DAM

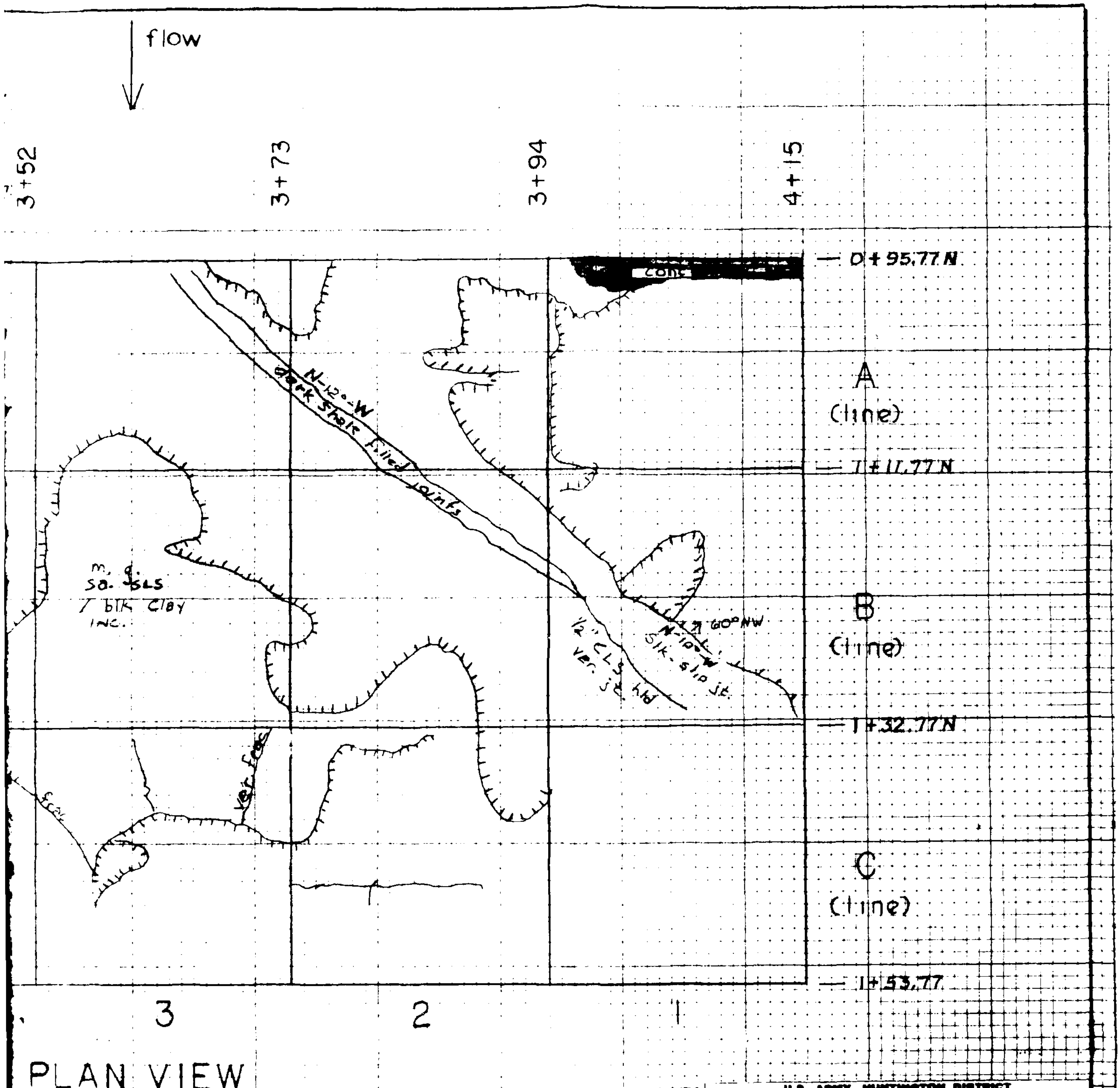
EXPLORATORY BORINGS
INSTRUMENTATION
PHOTOGRAPHS

Scale: 1" = 20'   PLAN VIEW

EXHIBIT NO. 9-19B



3+10
3+31
3+52
0+92.27 N
frac.
vert. frac.
dk. SH f.l. jt.
DUE E
frac.
frac.
5
4
PLAN



U.S. ARMY, HUNTINGTON DISTRICT
CORPS OF ENGINEERS

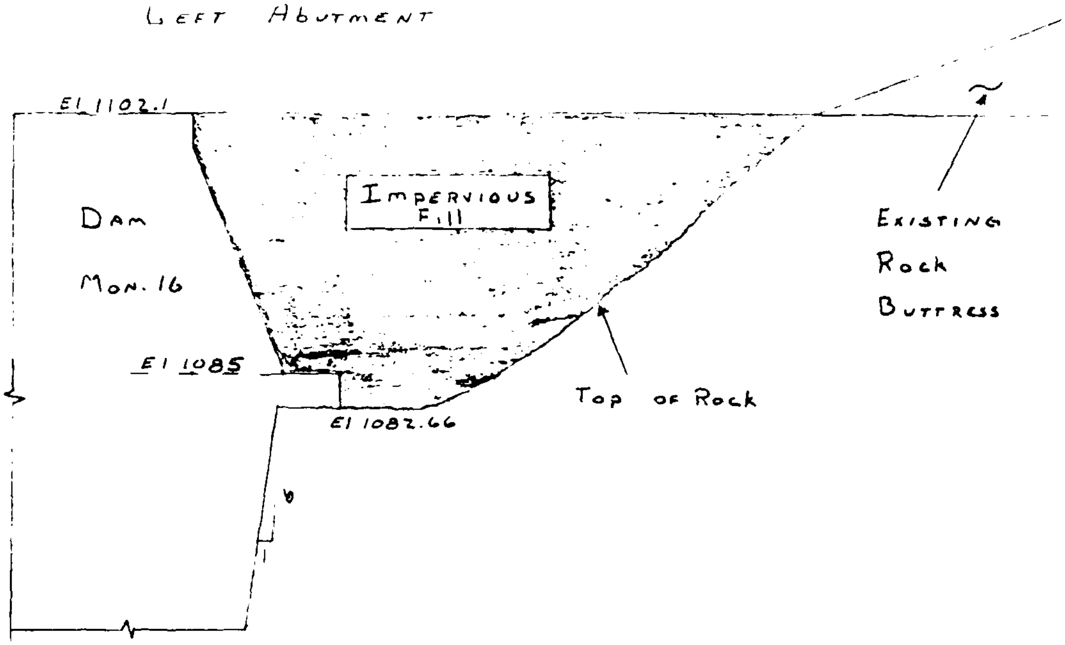
FOUNDATION REPORT
WEST FORK RIVER, WEST VIRGINIA
STONEWALL JACKSON DAM

FOUNDATION GEOLOGY
STILLING BASIN

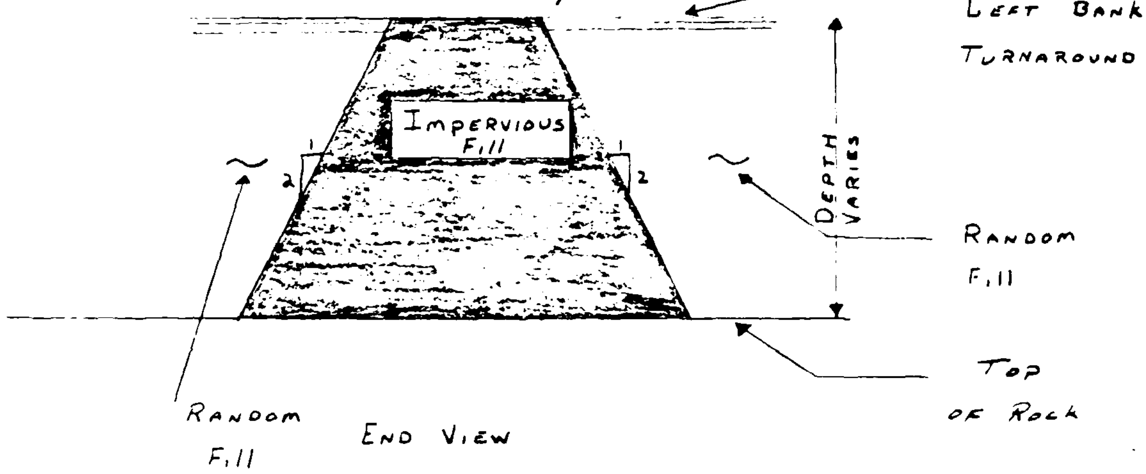
Scale: 1" = 10' PLAN VIEW

EXHIBIT NO. 9-19C

Impervious Fill
Left Abutment



Cross Section View



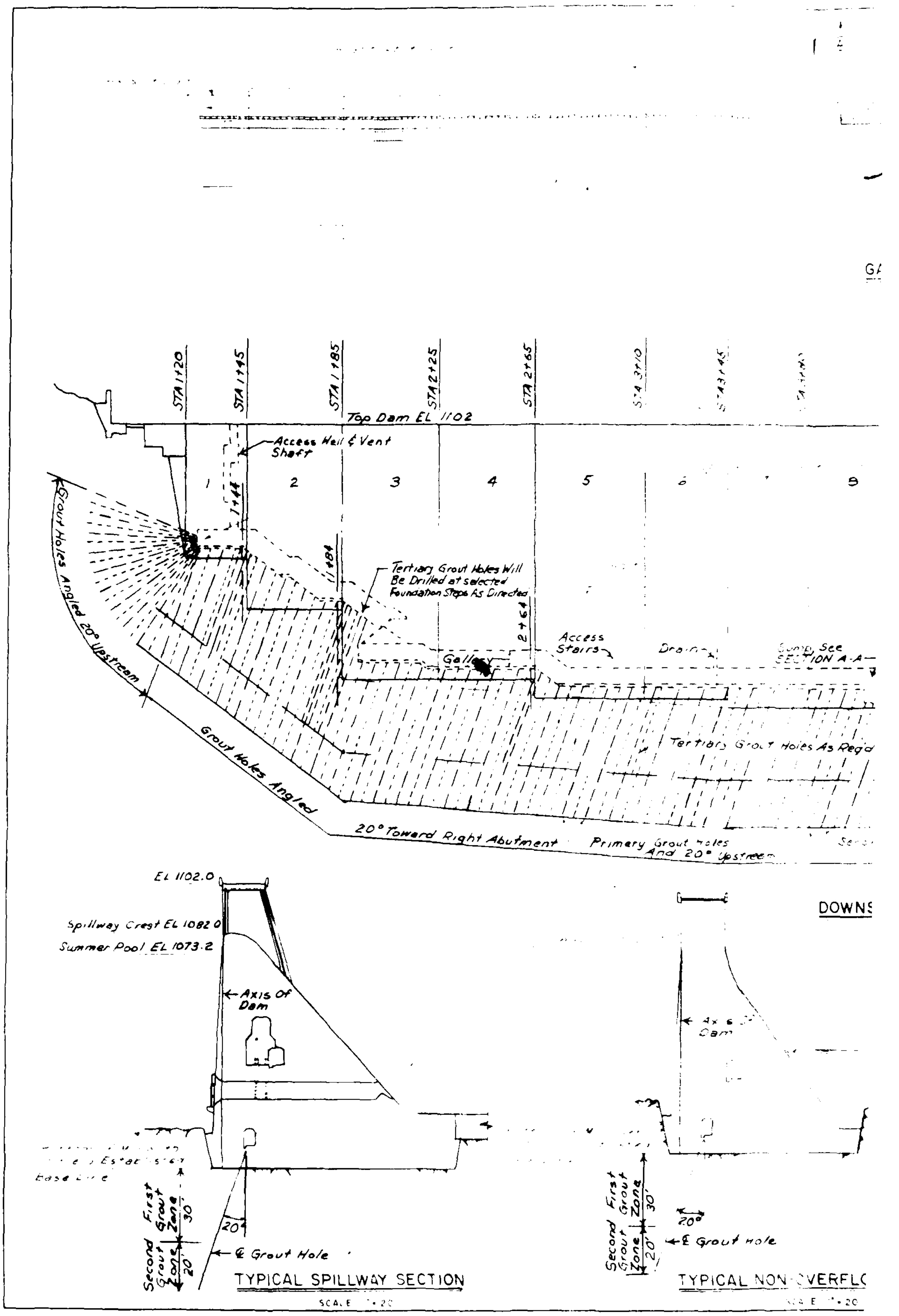
End View

U.S. ARMY, HUNTINGTON DISTRICT
CORPS OF ENGINEERS

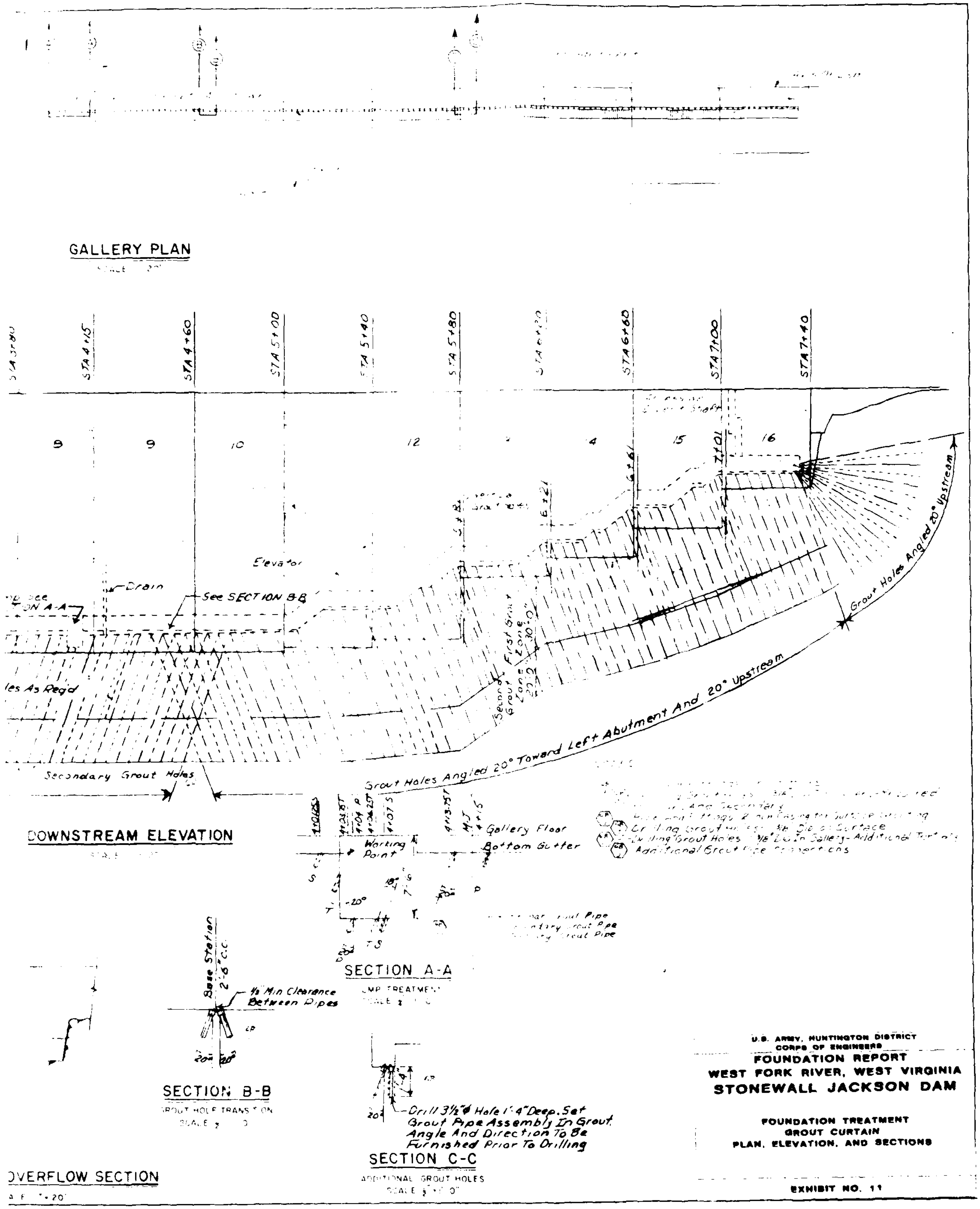
FOUNDATION REPORT
WEST FORK RIVER, WEST VIRGINIA
STONEWALL JACKSON DAM

IMPERVIOUS FILL

EXHIBIT NO. 10



STA 1+20
STA 1+45
STA 1+85
STA 2+25
STA 2+65
STA 3+10
STA 3+45
Top Dam EL 1102
Access Well & Vent Shaft
1
2
3
4
5
9
1+44
1+84
2+64
Grout Holes Angled 20° Upstream
Tertiary Grout Holes Will Be Drilled at selected Foundation Steps As Directed
Access Stairs
Gallery
Tertiary Grout Holes As Req'd
Grout Holes Angled
20° Toward Right Abutment
Primary Grout Holes And 20° Upstream
DOWNS
EL 1102.0
Spillway Crest EL 1082.0
Summer Pool EL 1073.2
Axis Of Dam
First Grout Zone
30'
Second Grout Zone
20'
20°
℄ Grout Hole
TYPICAL SPILLWAY SECTION
℄ Grout Hole
TYPICAL NON-OVERFL


GALLERY PLAN
STA 4+15
STA 4+60
STA 5+00
STA 5+40
STA 5+80
STA 6+60
STA 7+00
STA 7+40
9
9
10
12
15
16
Elevator
Drain
See SECTION B-B
Secondary Grout Holes
First Grout Zone 30'
Second Grout Zone
Grout Holes Angled 20° Toward Left Abutment And 20° Upstream
Grout Holes Angled 20° Upstream
DOWNSTREAM ELEVATION
Gallery Floor
Bottom Gutter
Working Point
SECTION A-A
Base Station 2'-6" C.C.
1/2" Min Clearance Between Pipes
SECTION B-B
GROUT HOLE TRANSITION
Drill 3½"Ø Hole 1'-4" Deep. Set Grout Pipe Assembly In Grout. Angle And Direction To Be Furnished Prior To Drilling
SECTION C-C
ADDITIONAL GROUT HOLES
OVERFLOW SECTION
U.S. ARMY, HUNTINGTON DISTRICT
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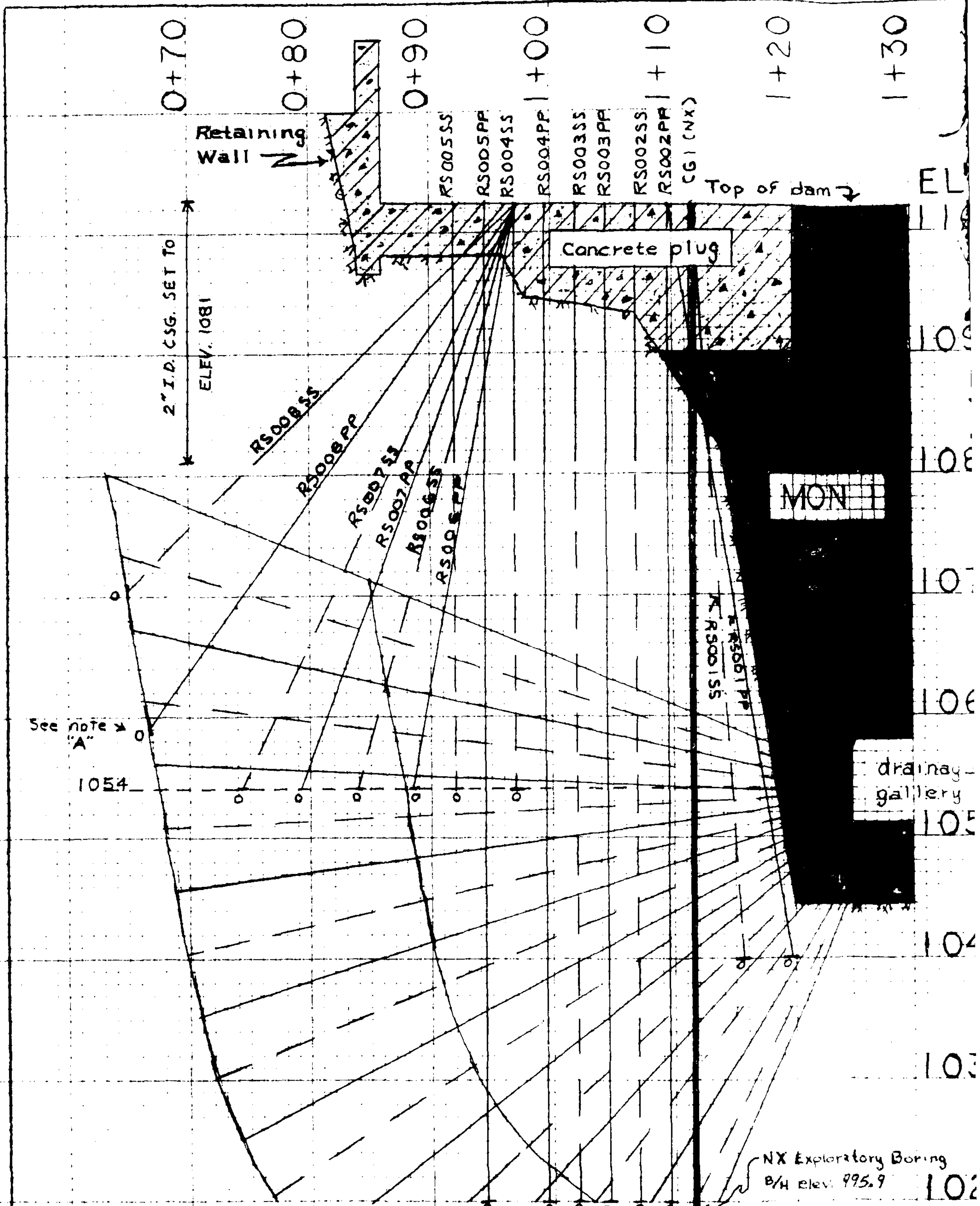
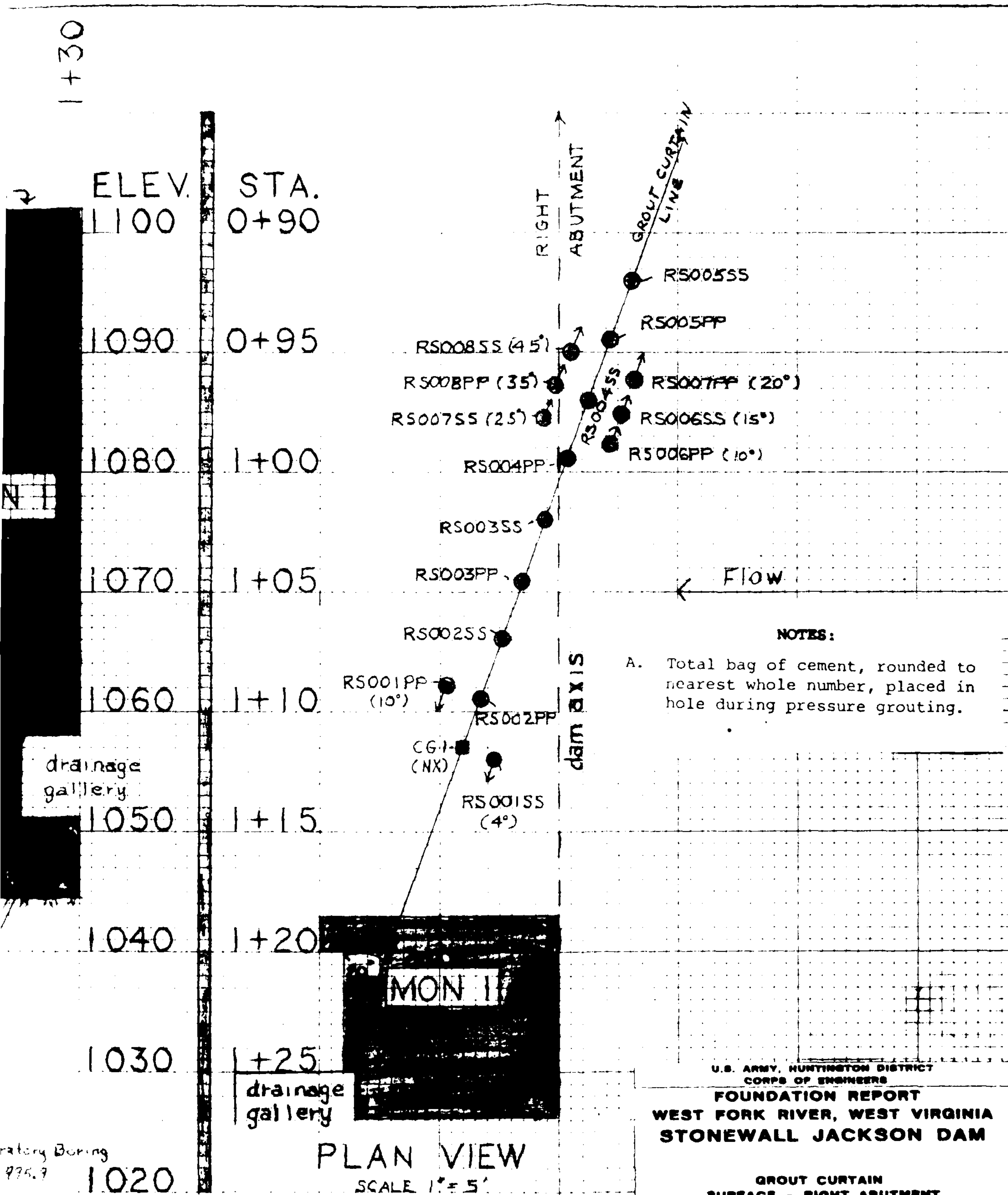
FOUNDATION REPORT
WEST FORK RIVER, WEST VIRGINIA
STONEWALL JACKSON DAM
FOUNDATION TREATMENT
GROUT CURTAIN
PLAN, ELEVATION, AND SECTIONS
EXHIBIT NO. 11



X-SECTION VIEW
FACING UPSTREAM
SCALE 1" = 10'



NOTES:

A. Total bag of cement, rounded to nearest whole number, placed in hole during pressure grouting.

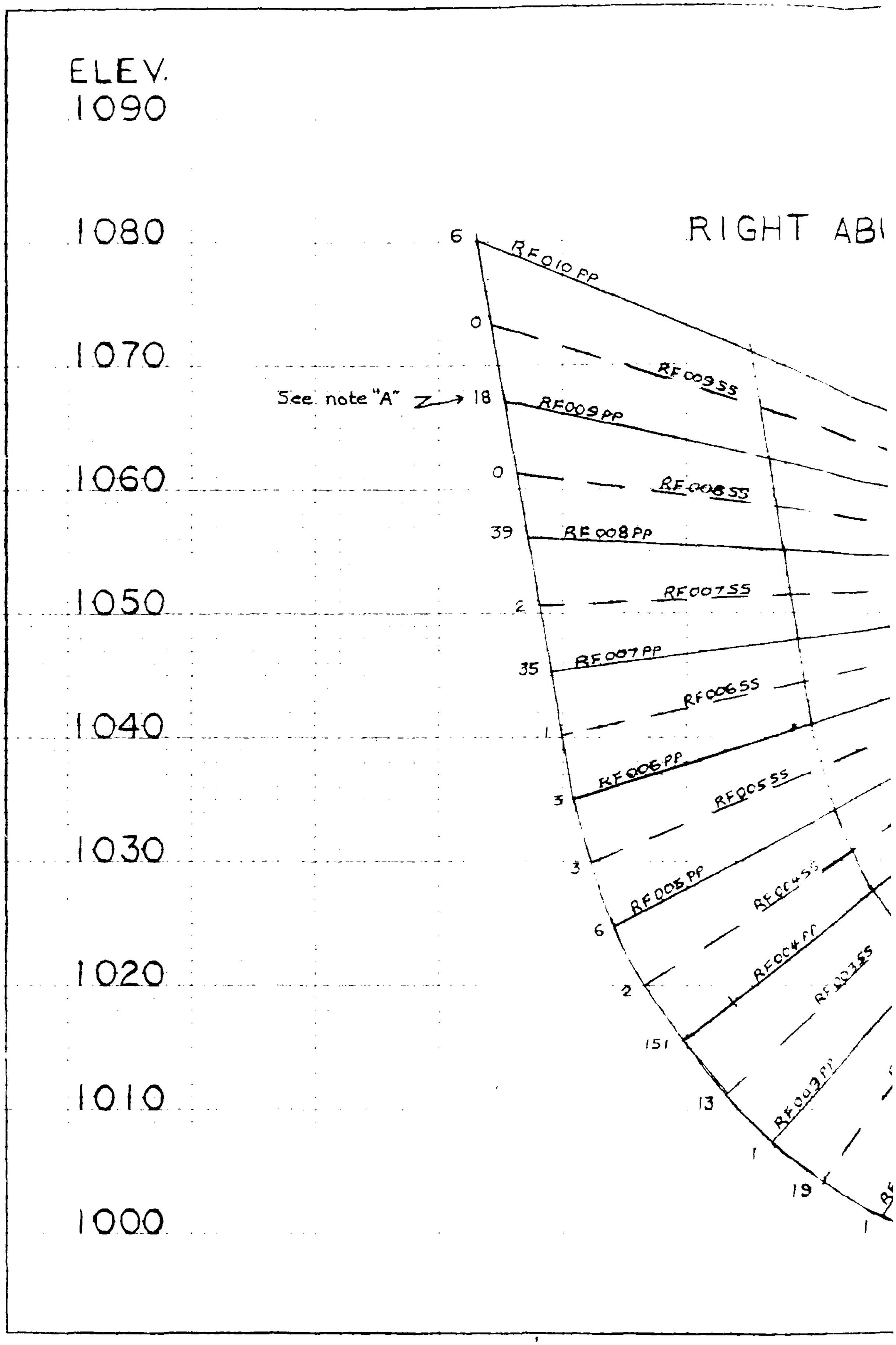
U.S. ARMY, HUNTINGTON DISTRICT
CORPS OF ENGINEERS

FOUNDATION REPORT
WEST FORK RIVER, WEST VIRGINIA
STONEWALL JACKSON DAM

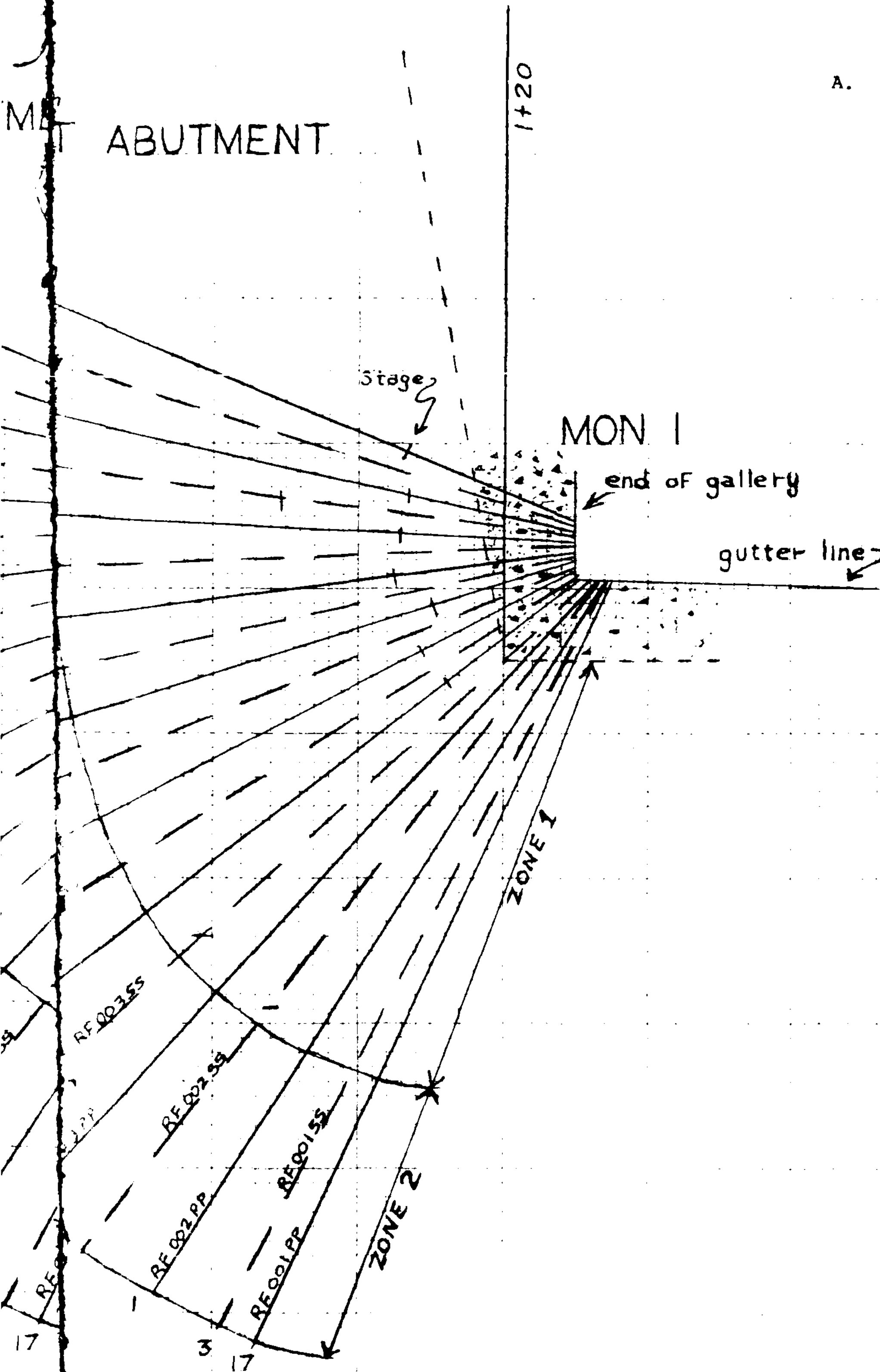
GROUT CURTAIN
SURFACE - RIGHT ABUTMENT
STA. 0+92.00 - 1+11.50

Scale: AS SHOWN

EXHIBIT NO. 11-1



ELEV.
1090
1080
1070
1060
1050
1040
1030
1020
1010
1000
RIGHT AB
6
RF010PP
0
RF009SS
See note "A"
18
RF009PP
0
RF008SS
39
RF008PP
RF007SS
2
35
RF007PP
RF006SS
1
RF006PP
3
RF005SS
3
RF005PP
6
RF004SS
2
RF004PP
RF003SS
151
13
RF003PP
1
19
1



NOTES:

A. Total bag of cement, rounded to nearest whole number, placed in hole during pressure grouting.

U.S. ARMY, HUNTINGTON DISTRICT
CORPS OF ENGINEERS

FOUNDATION REPORT

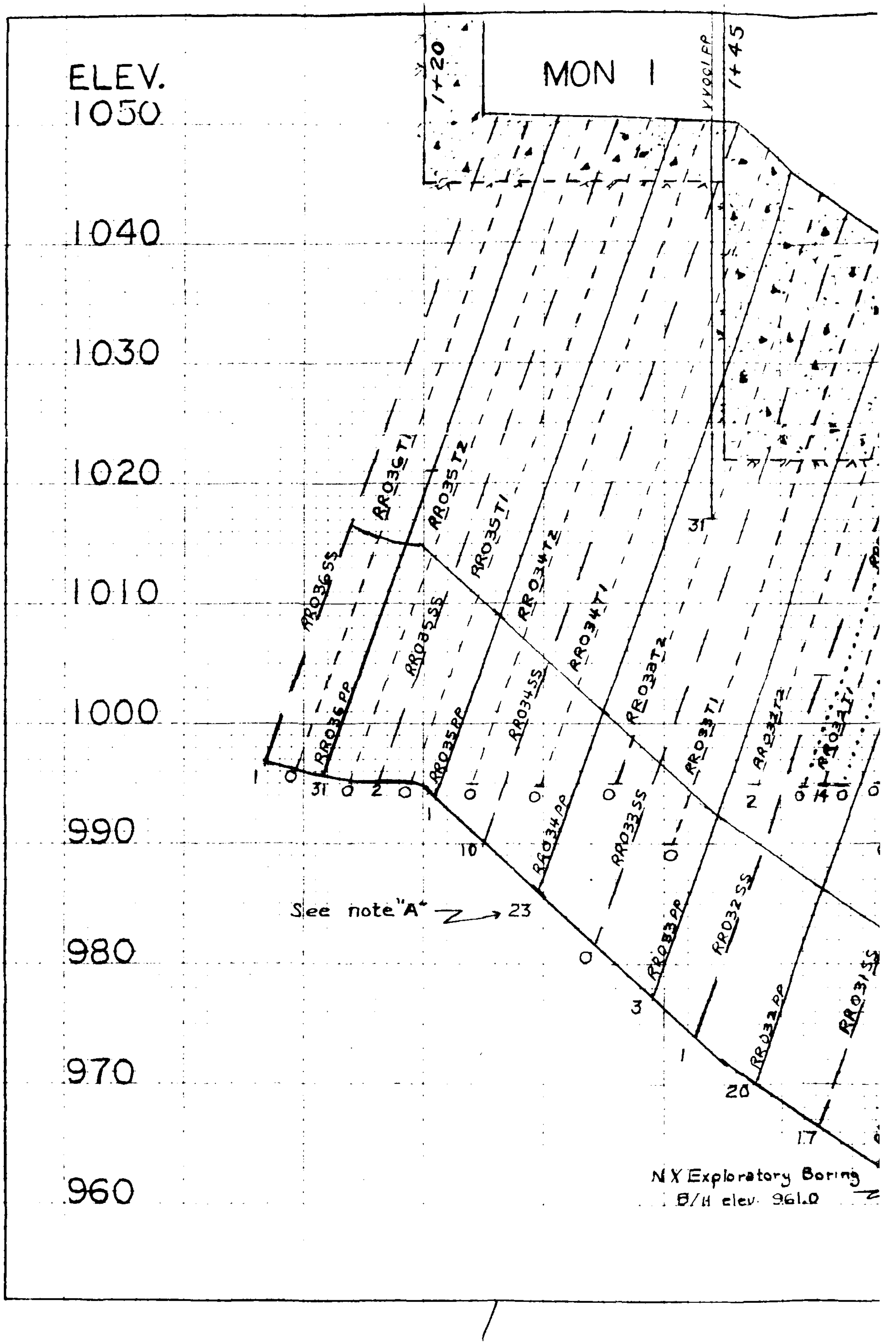
WEST FORK RIVER, WEST VIRGINIA

STONEWALL JACKSON DAM

GROUT CURTAIN
GALLERY - RIGHT FAN
STA. 1+25.00 - 1+27.04

Scale: 1" = 10'

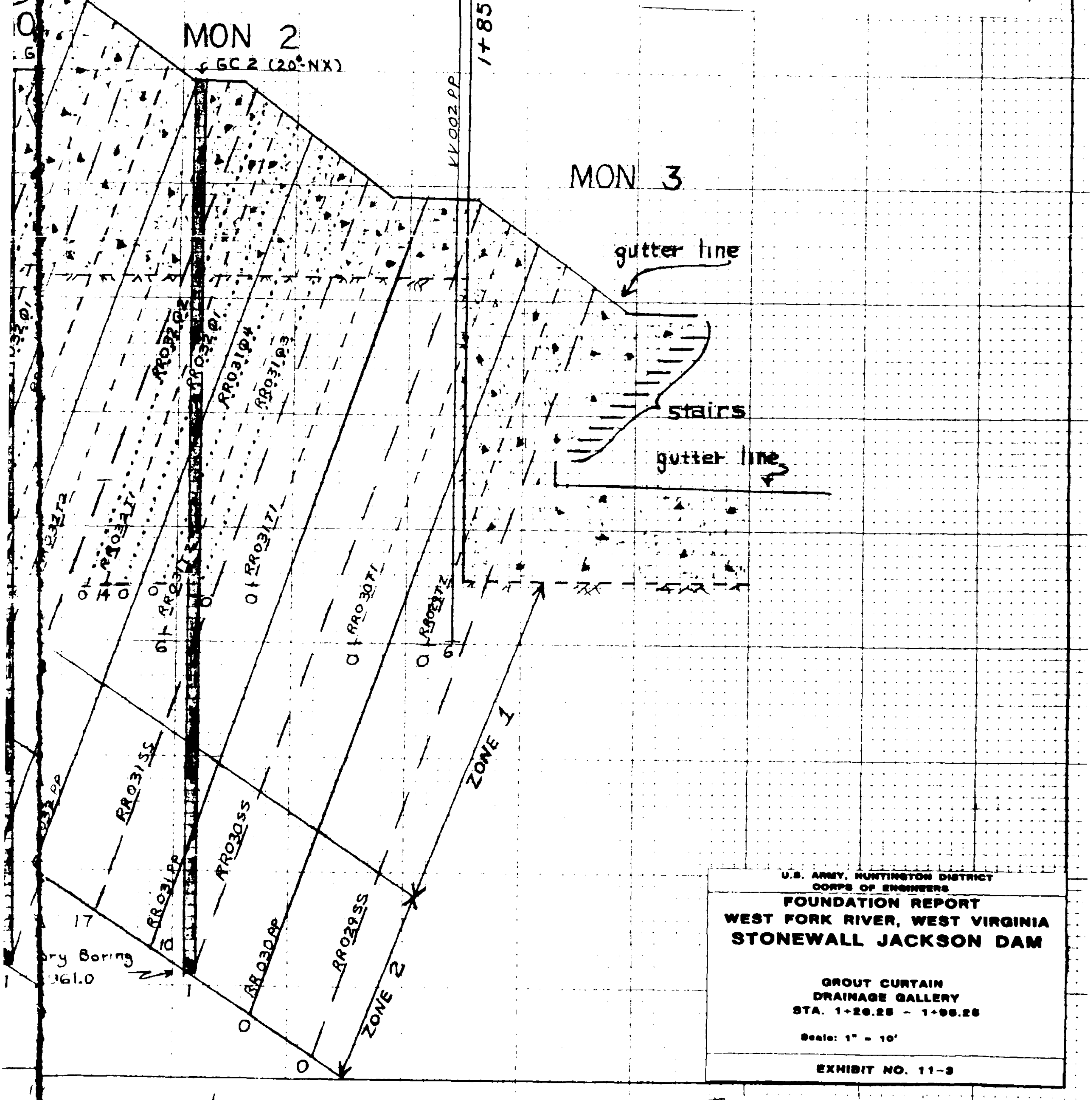
EXHIBIT NO. 11-2



ELEV.
1050
1040
1030
1020
1010
1000
990
980
970
960
MON 1
1+20
1+45
YVO01PP
RR036T1
RR035T2
RR035T1
RR034T2
RR034T1
RR033T2
RR033T1
RR036SS
RR035SS
RR034SS
RR036PP
RR035PP
RR034PP
RR033SS
RR033PP
RR032SS
RR032PP
RR031SS
See note "A"
23
N X Exploratory Boring
B/H elev. 961.0

NOTES:

A. Total bag of cement, rounded to nearest whole number, placed in hole during pressure grouting.



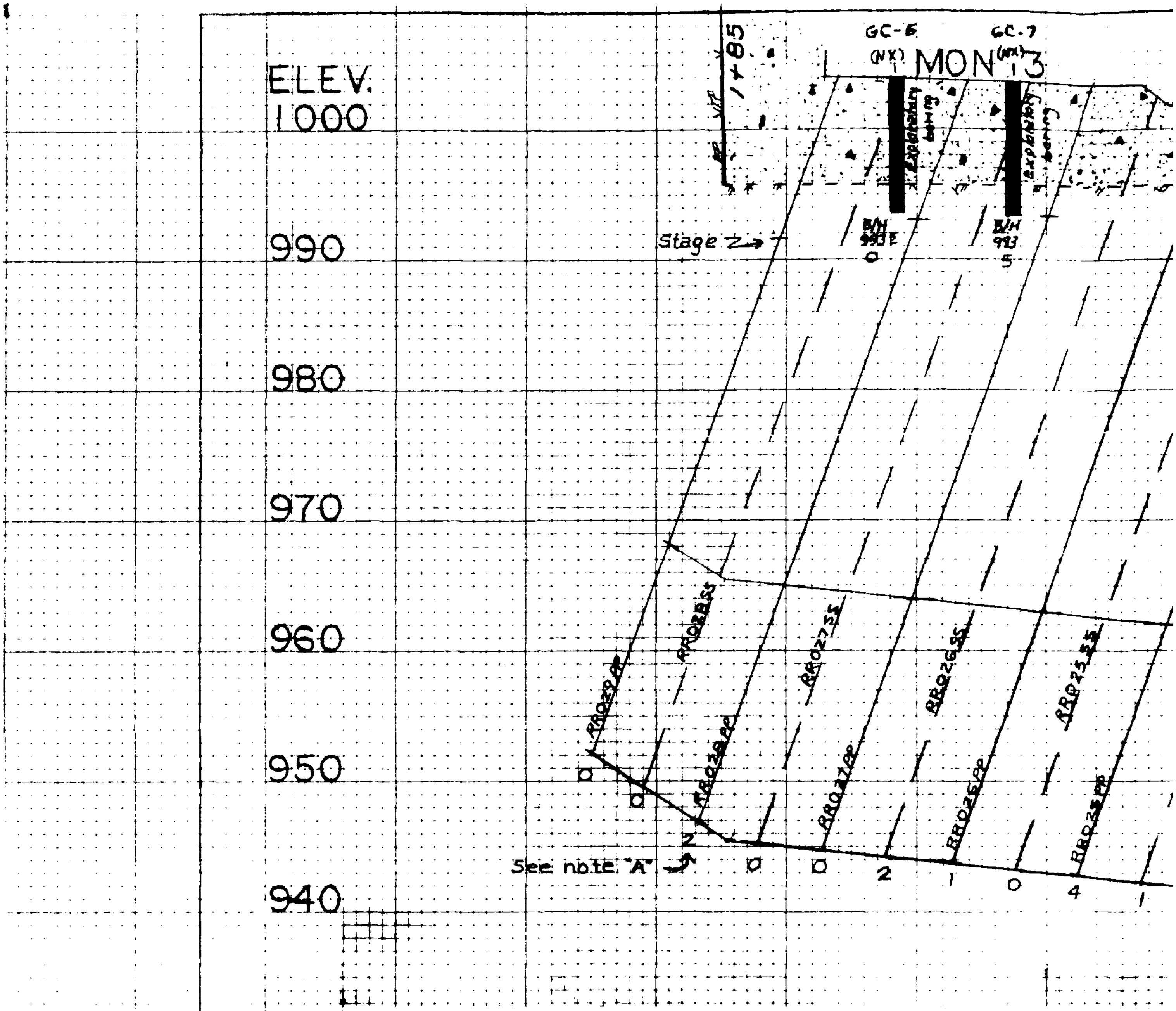
U.S. ARMY, HUNTINGTON DISTRICT
CORPS OF ENGINEERS

FOUNDATION REPORT
WEST FORK RIVER, WEST VIRGINIA
STONEWALL JACKSON DAM

GROUT CURTAIN
DRAINAGE GALLERY
STA. 1+20.25 - 1+96.25

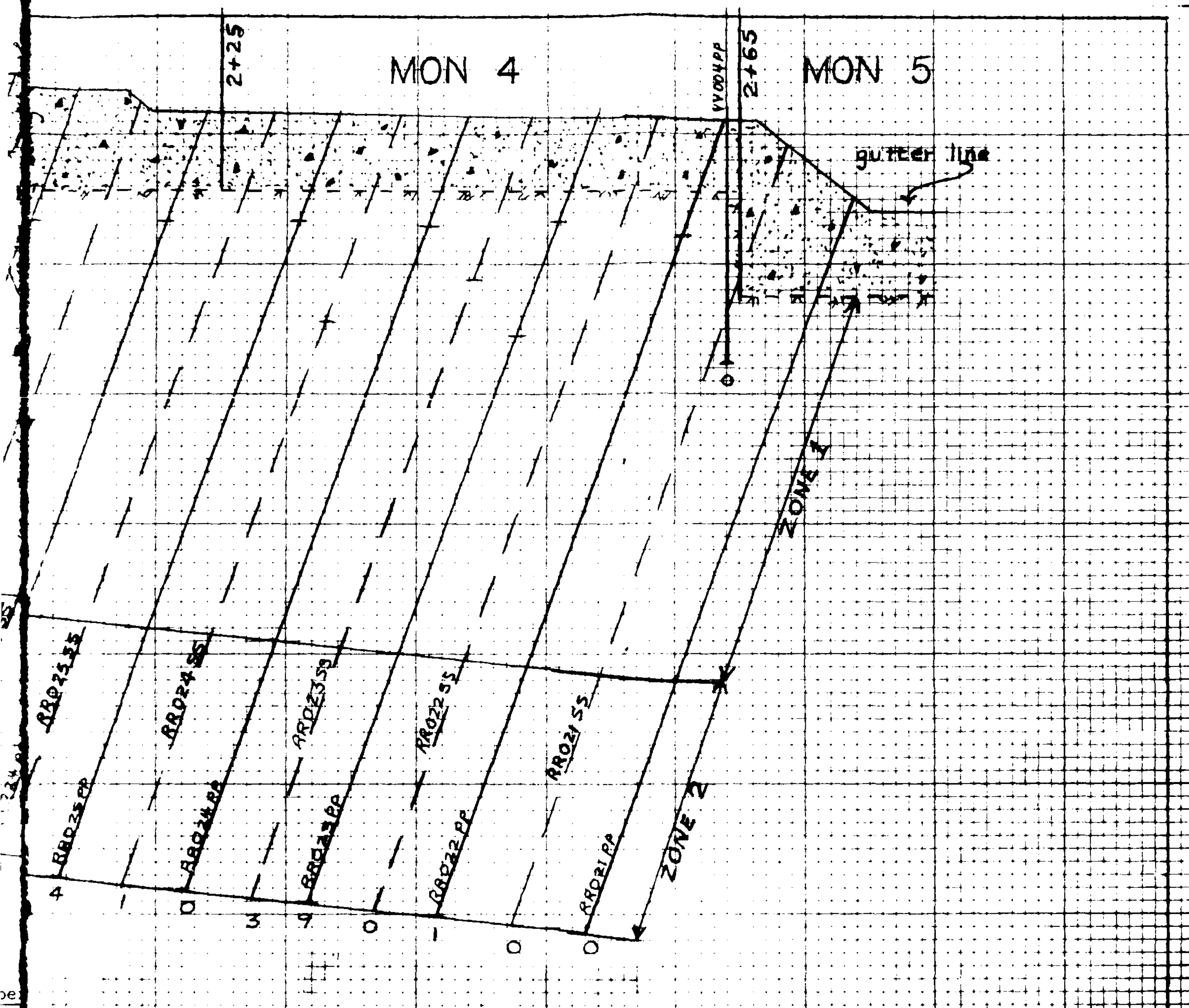
Scale: 1" = 10'

EXHIBIT NO. 11-3



Number Prefix:

RR = Grout holes angled 20° u/s and toward right abutment.
RF = Grout holes angled 20° u/s and into the right abutment.
RS = Grout holes drilled from surface of right abutment.
LL = Grout holes angled 20° u/s and toward left abutment.
LF = Grout holes angled 20° u/s and into the left abutment.
LS = Grout holes drilled from surface of left abutment.
VV = Grout holes drilled vertically near a monolith joint.
LD = Special grout holes along Monolith 13 and 14 joint face.
GC = Exploratory NX core boring.



Number Suffix:

PP = Primary holes (1st series)
SS = Secondary holes (2nd series)
T No. = Tertiary holes (3rd series)
Q No. = Quarternary holes (4th series)

NOTES:

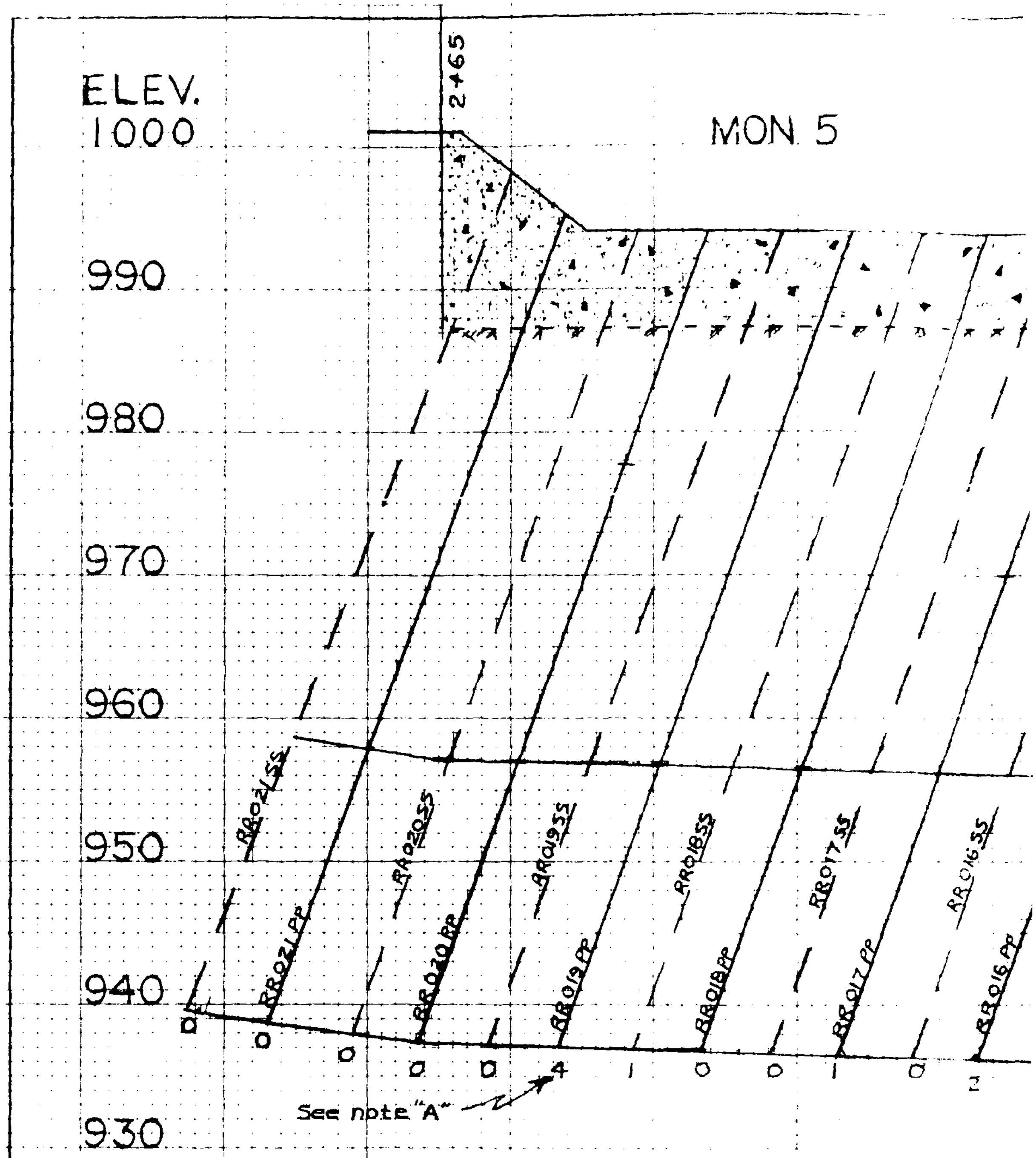
A. Total bag of cement, rounded to nearest whole number, placed in hole during pressure grouting.

U.S. ARMY, HUNTINGTON DISTRICT
CORPS OF ENGINEERS
FOUNDATION REPORT
WEST FORK RIVER, WEST VIRGINIA
STONEWALL JACKSON DAM

GROUT CURTAIN
DRAINAGE GALLERY
STA. 1+98.25 - 2+73.75

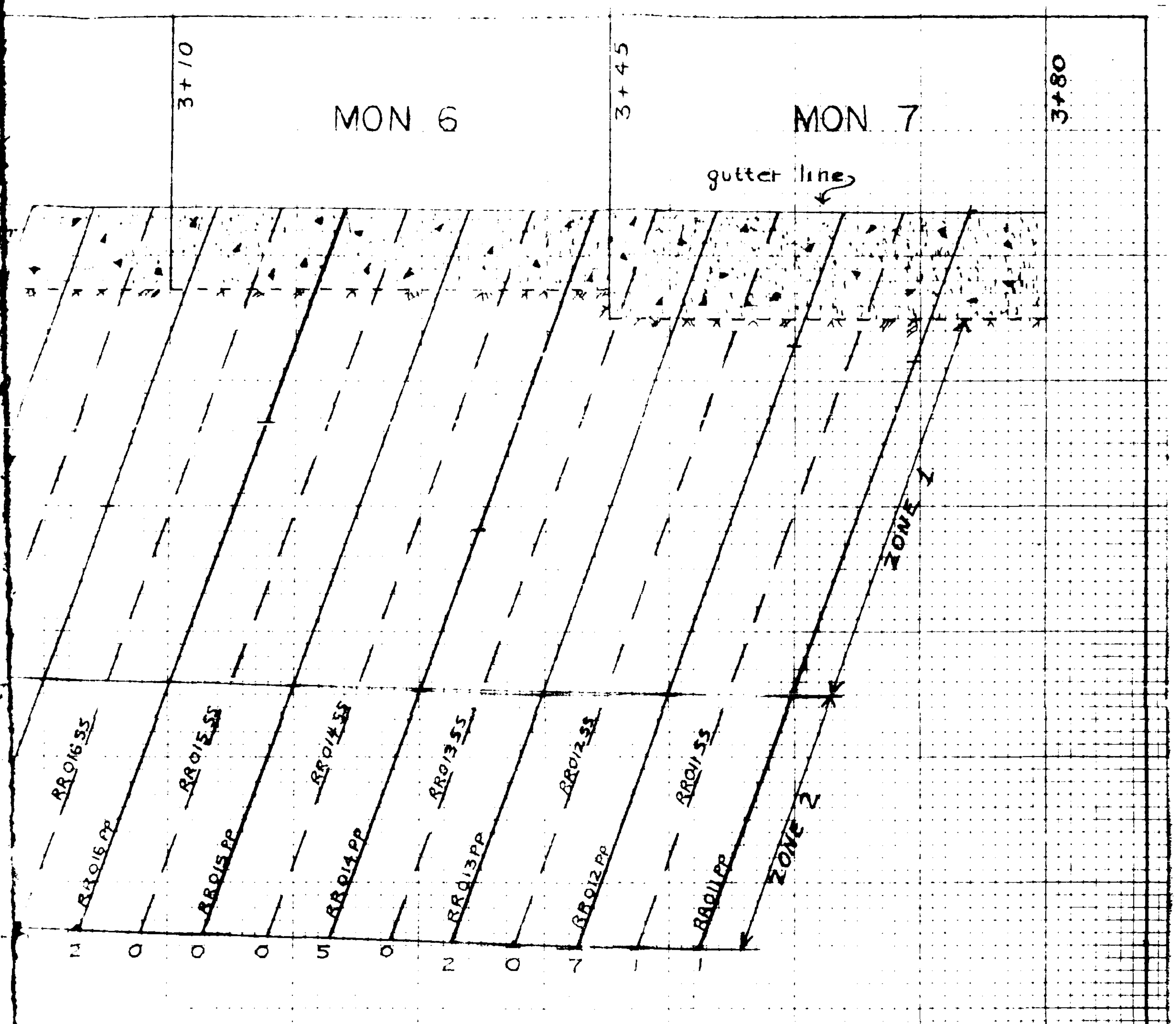
Scale: 1" = 10'

EXHIBIT NO. 11-4



NOTES:

A. Total bag of ce... ...nde... nearest whole nu... ...laced... hole during press... ...ti...



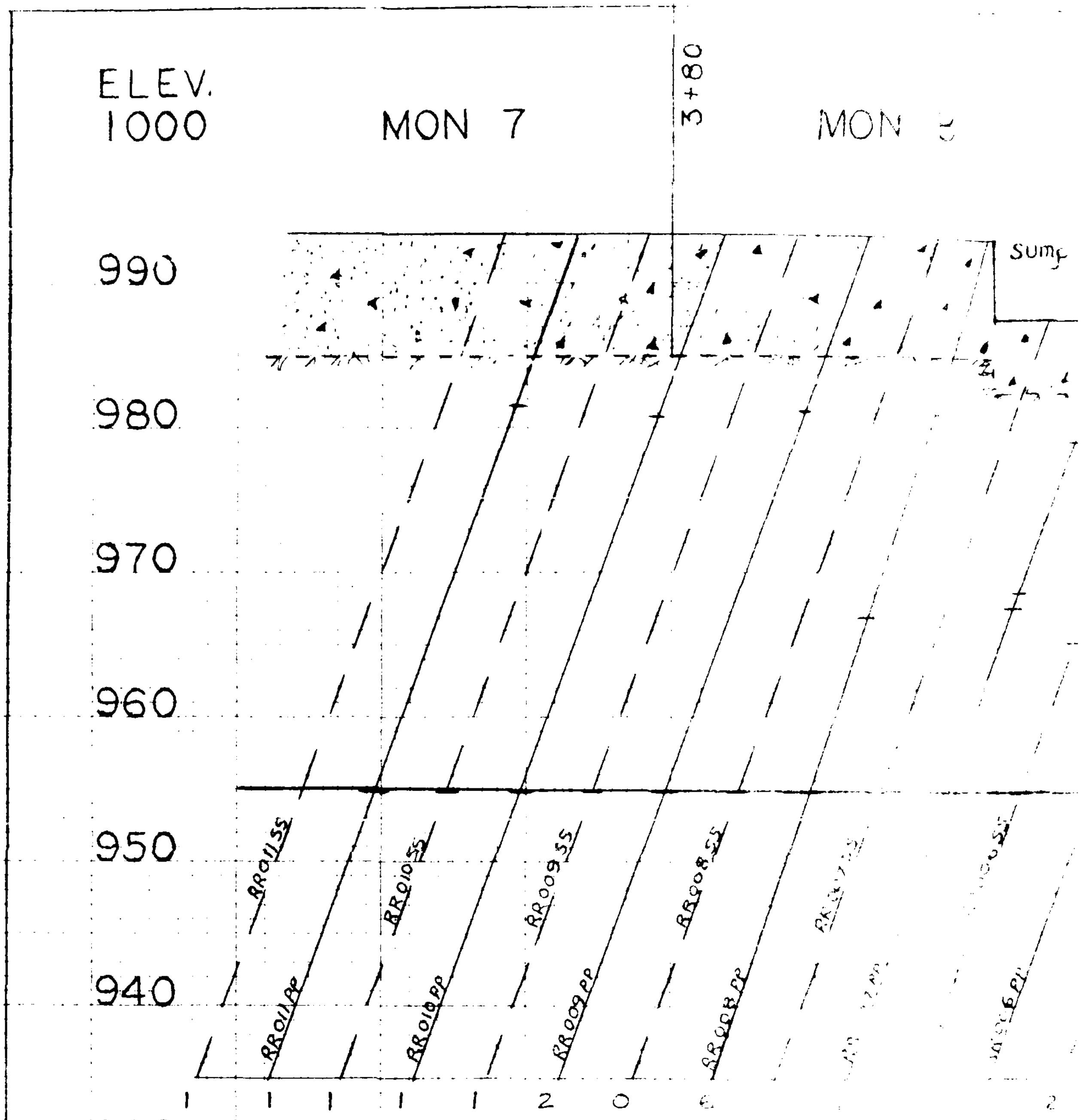
U.S. ARMY, HUNTINGTON DISTRICT
CORPS OF ENGINEERS

FOUNDATION REPORT
WEST FORK RIVER, WEST VIRGINIA
STONEWALL JACKSON DAM

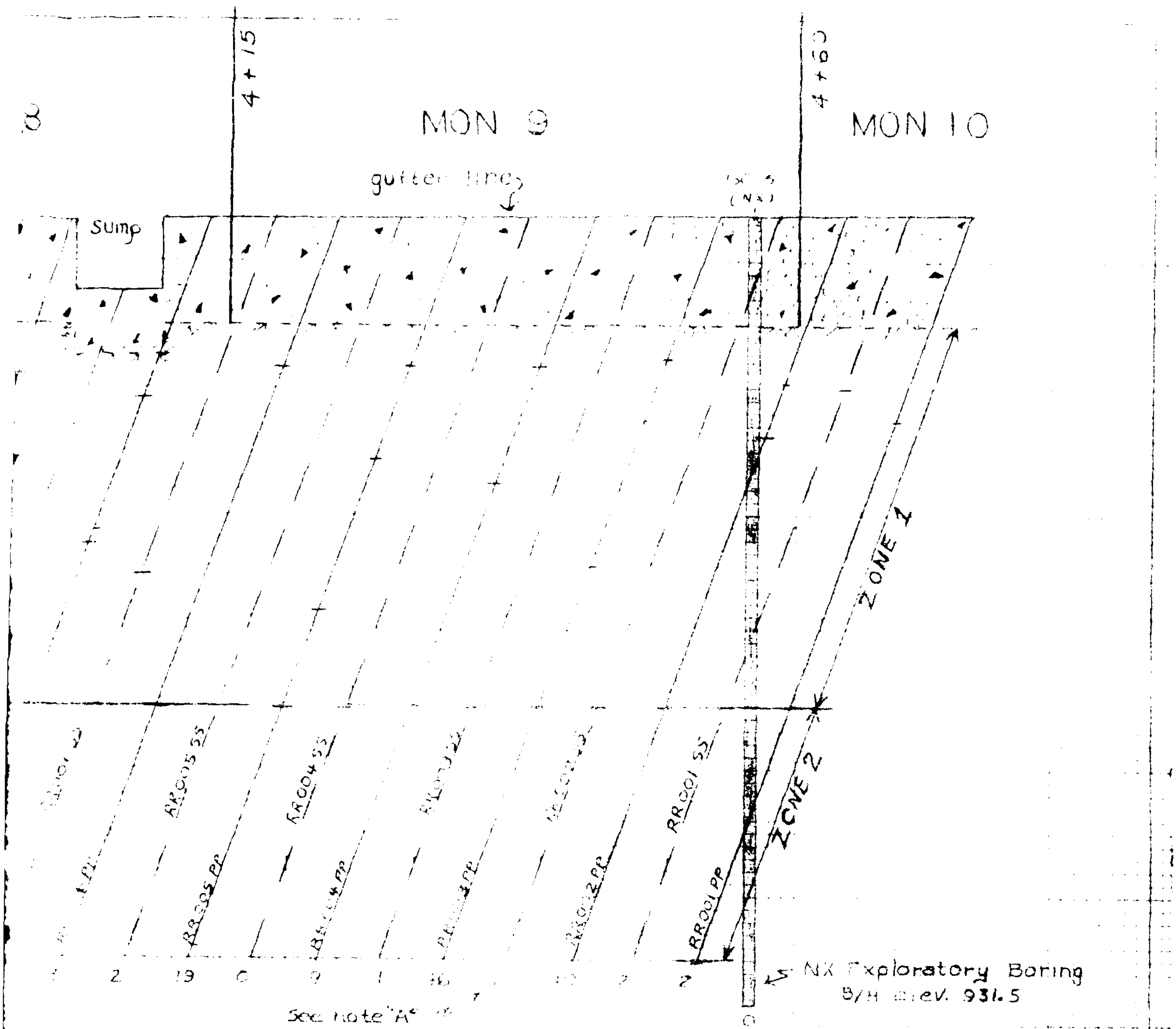
GROUT CURTAIN
DRAINAGE GALLERY
STA. 2+68.75 - 3+78.75

Scale: 1" = 10'

EXHIBIT NO. 11-5



A. Total bag of cem... rounded ... nearest whole ... placed ... hole during ... grouting.



rounded to
placed in
ing.

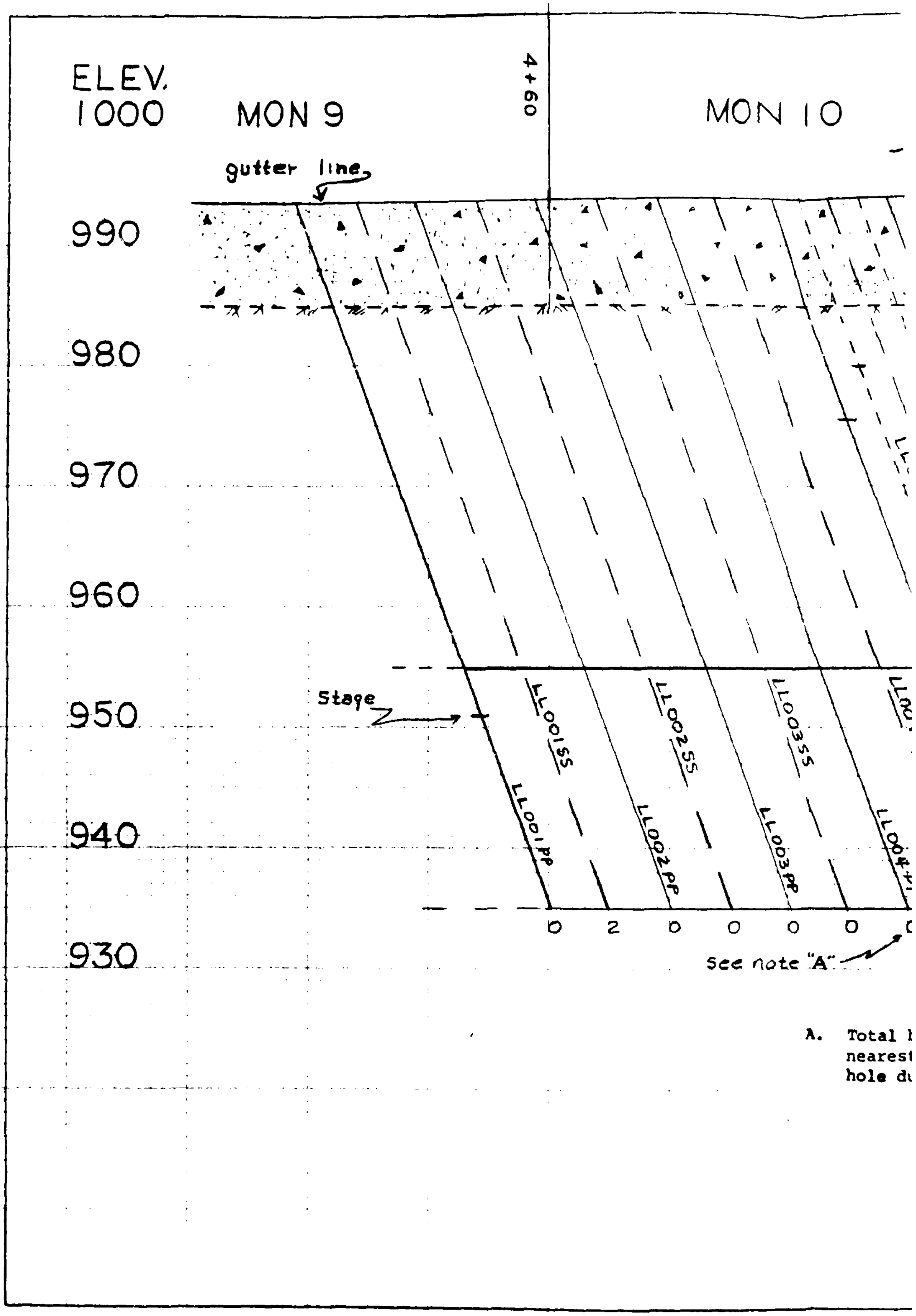
U.S. ARMY, HUNTINGTON DISTRICT
CORPS OF ENGINEERS

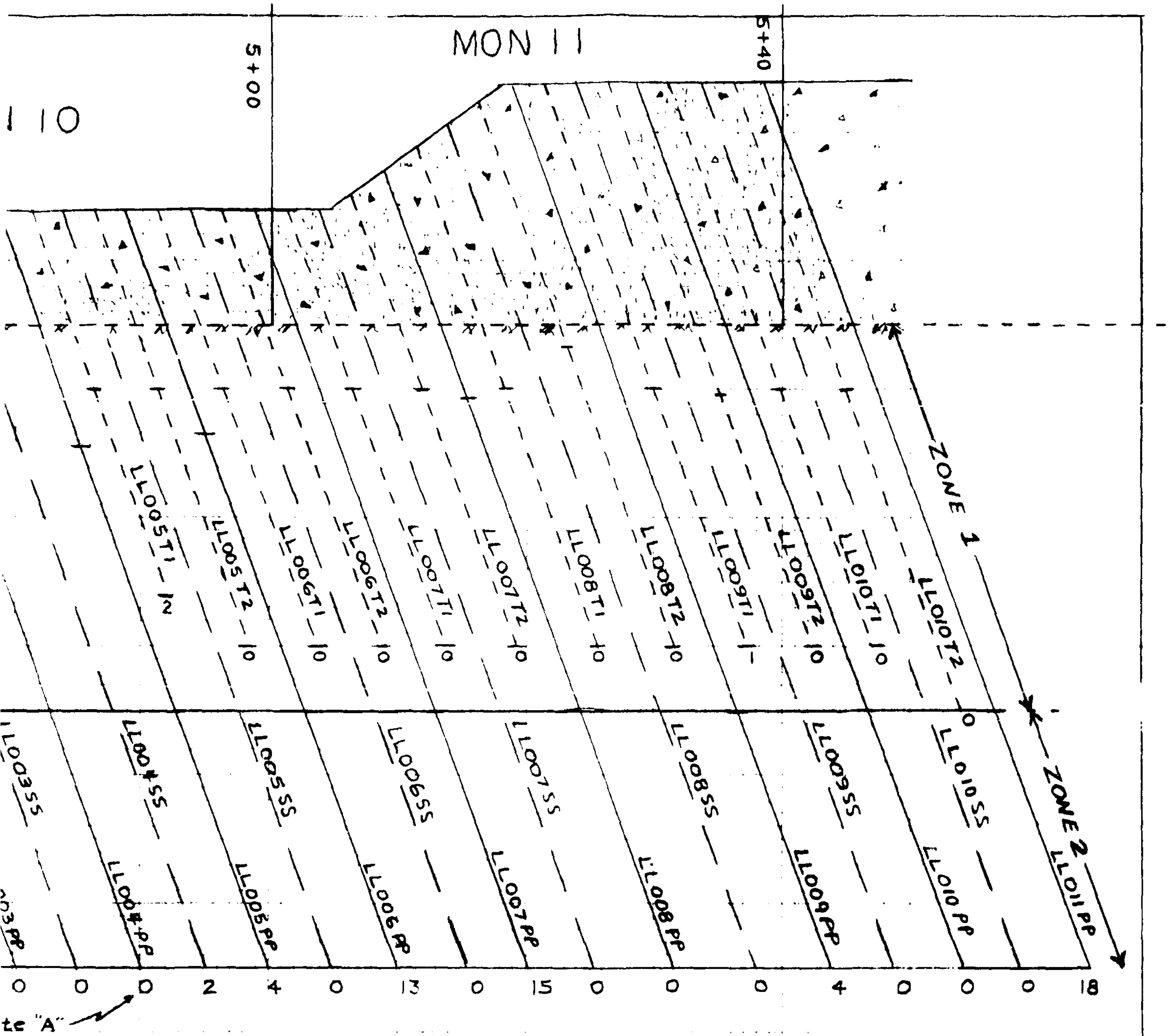
FOUNDATION REPORT
WEST FORK RIVER, WEST VIRGINIA
STONEWALL JACKSON DAM

GROUT CURTAIN
DRAINAGE GALLERY
STA. 3+68.75 - 4+73.75

Scale 1" = 10'

EXHIBIT NO. 11-[illegible]


ELEV.
1000
MON 9
4+60
MON 10
gutter line
990
980
970
960
950
940
930
Stage
LL001SS
LL002SS
LL003SS
LL001PP
LL002PP
LL003PP
0
2
0
0
0
0
See note "A"
A. Total
nearest
hole d



NOTES:

A. Total bag of cement, rounded to nearest whole number, placed in hole during pressure grouting.

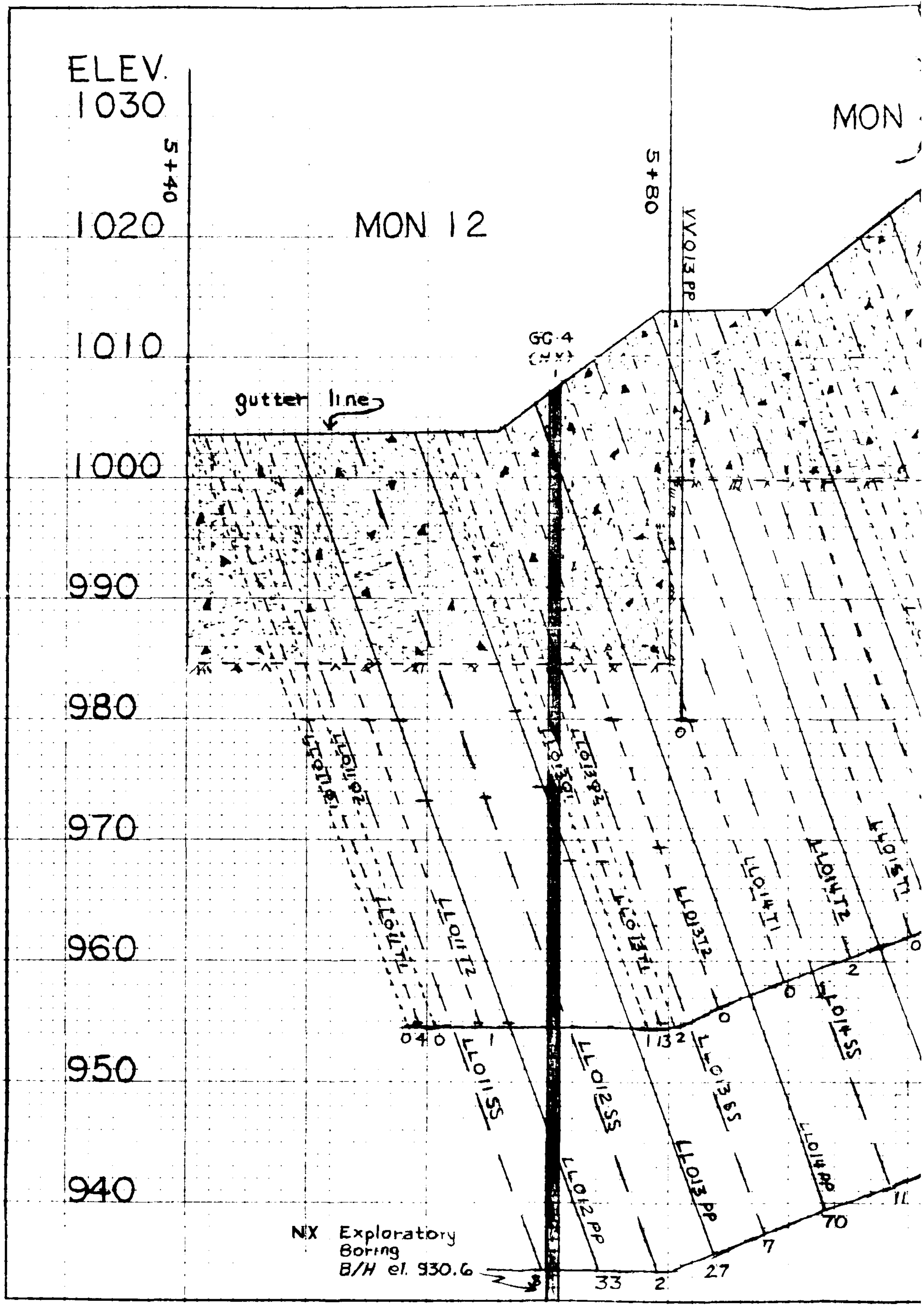
U.S. ARMY, HUNTINGTON DISTRICT
CORPS OF ENGINEERS

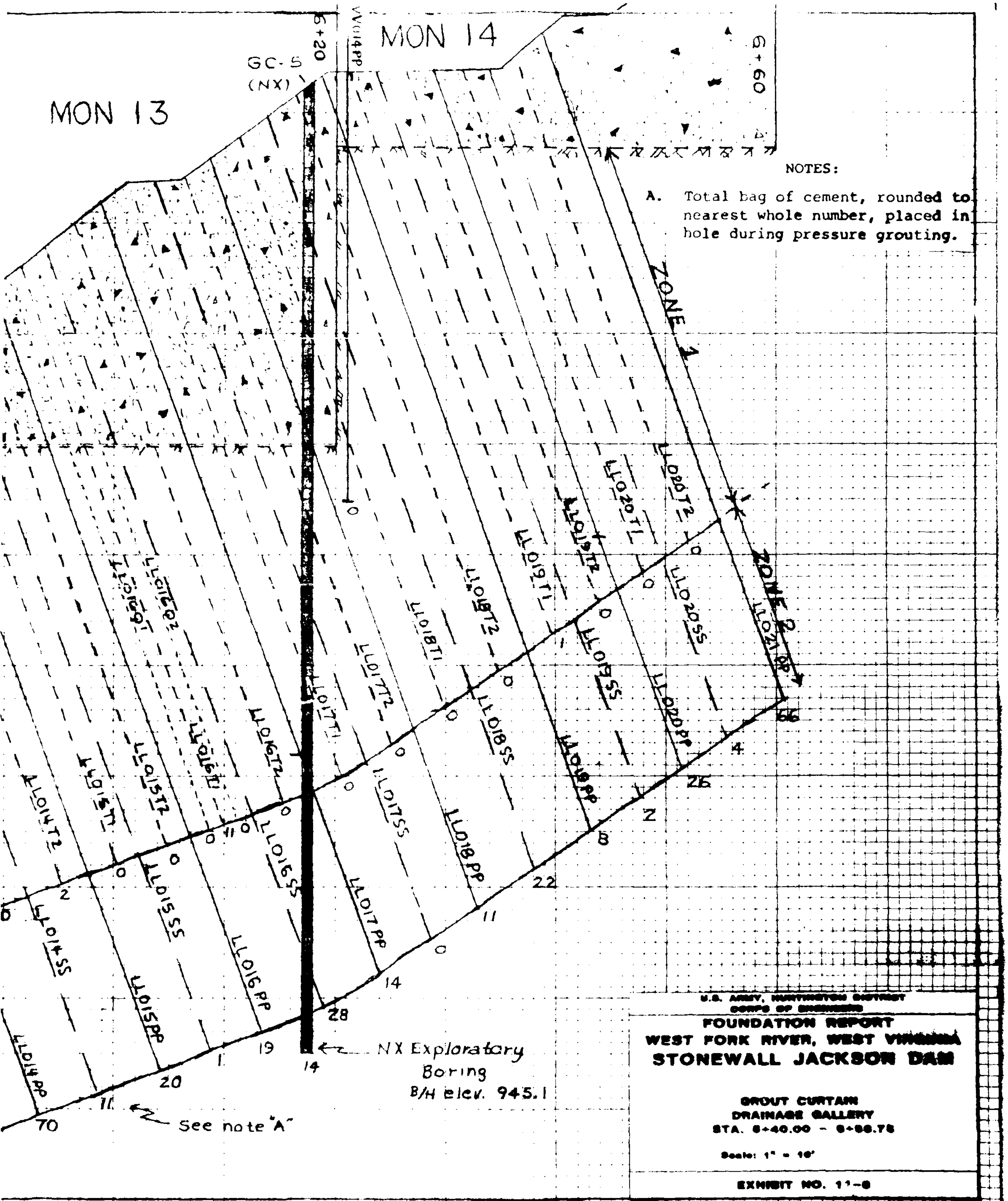
FOUNDATION REPORT
WEST FORK RIVER, WEST VIRGINIA
STONEWALL JACKSON DAM

GROUT CURTAIN
DRAINAGE GALLERY
STA. 4+38.78 - 5+38.78

Scale: 1" = 10'

EXHIBIT NO. 11-7


ELEV.
1030
1020
1010
1000
990
980
970
960
950
940
5+40
5+80
MON 12
MON
gutter line
GG-4
VY013PP
LL011T1
LL011T2
LL011SS
LL012SS
LL012PP
LL013T1
LL013T2
LL013SS
LL013PP
LL014T1
LL014T2
LL014SS
LL014PP
LL015T1
NX Exploratory Boring B/H el. 930.6
33
27
70



NOTES:

A. Total bag of cement, rounded to nearest whole number, placed in hole during pressure grouting.

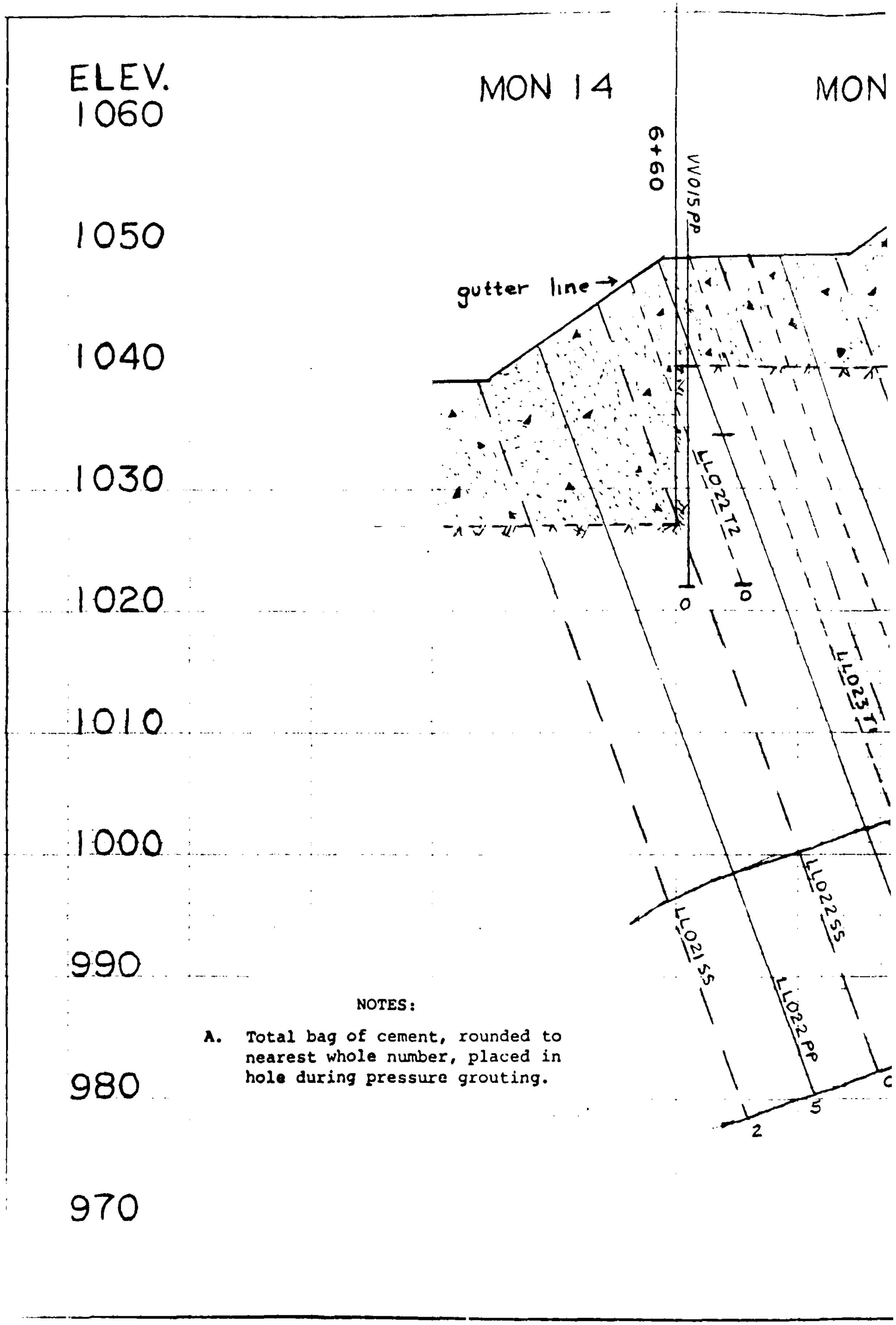
U.S. ARMY, HUNTINGTON DISTRICT
CORPS OF ENGINEERS

FOUNDATION REPORT
WEST FORK RIVER, WEST VIRGINIA
STONEWALL JACKSON DAM

GROUT CURTAIN
DRAINAGE GALLERY
STA. 6+40.00 – 6+86.75

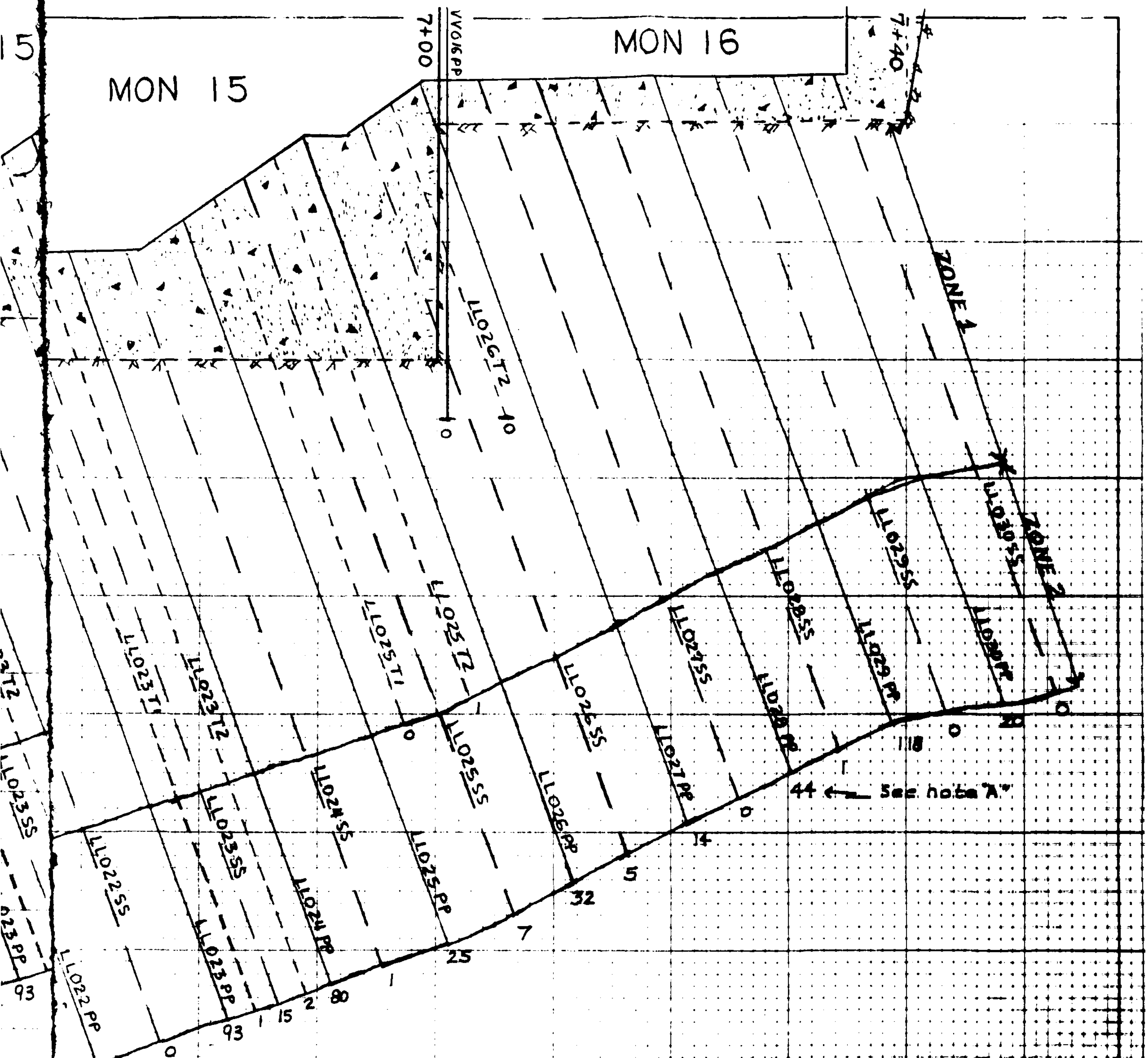
Scale: 1" = 10'

EXHIBIT NO. 11-6



NOTES:

A. Total bag of cement, rounded to nearest whole number, placed in hole during pressure grouting.



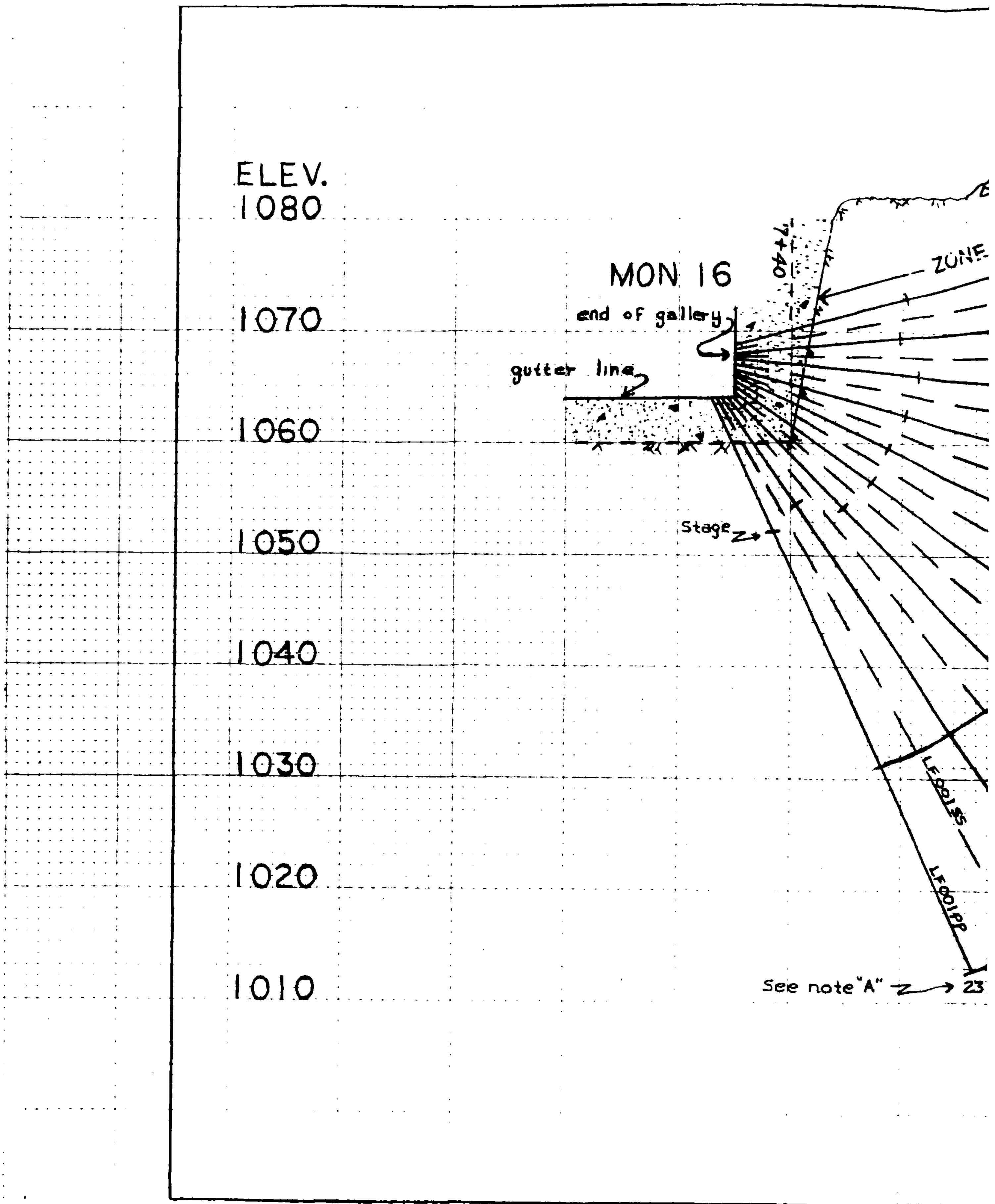
U.S. ARMY, HUNTINGTON DISTRICT
CORPS OF ENGINEERS

FOUNDATION REPORT
WEST FORK RIVER, WEST VIRGINIA
STONEWALL JACKSON DAM

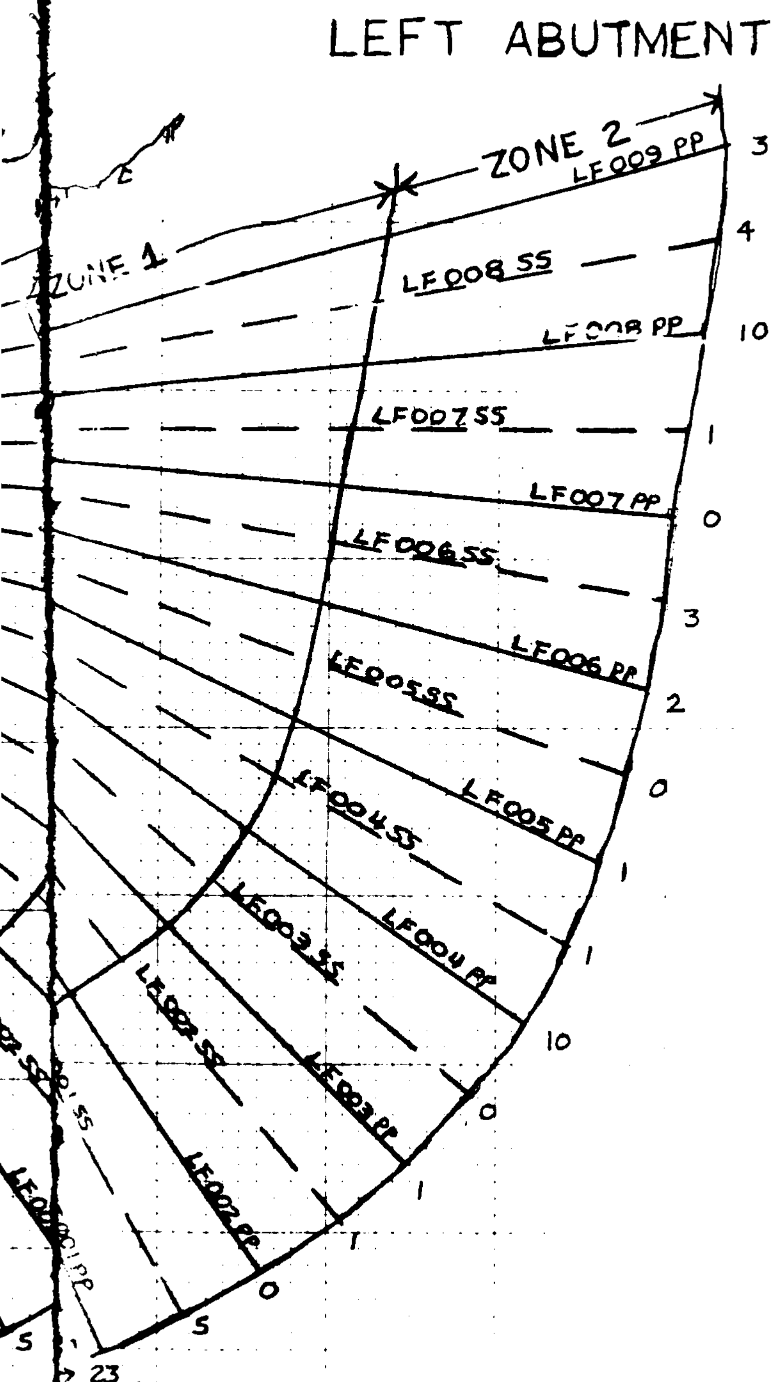
GROUT CURTAIN
DRAINAGE GALLERY
STA. 6+48.75 - 7+88.75

Scale: 1" = 10'

EXHIBIT NO. 11-b



ELEV.
1080
1070
1060
1050
1040
1030
1020
1010
MON 16
end of gallery
gutter line
7+40
ZONE
Stage
LF001SS
LF001PP
See note "A"
23



NOTES:

A. Total bag of cement, rounded to nearest whole number, placed in hole during pressure grouting.

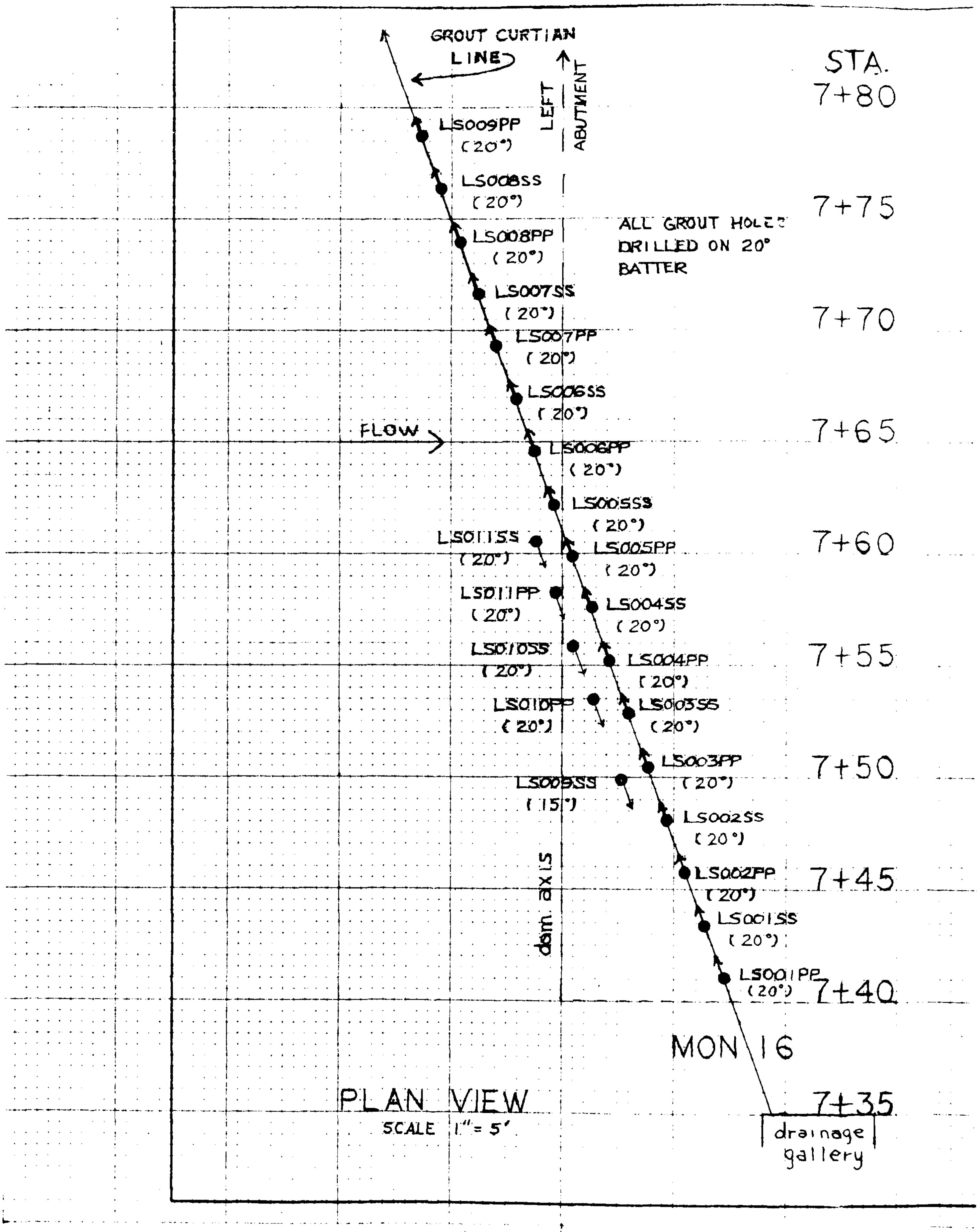
U.S. ARMY, HUNTINGTON DISTRICT
CORPS OF ENGINEERS

FOUNDATION REPORT
WEST FORK RIVER, WEST VIRGINIA
STONEWALL JACKSON DAM

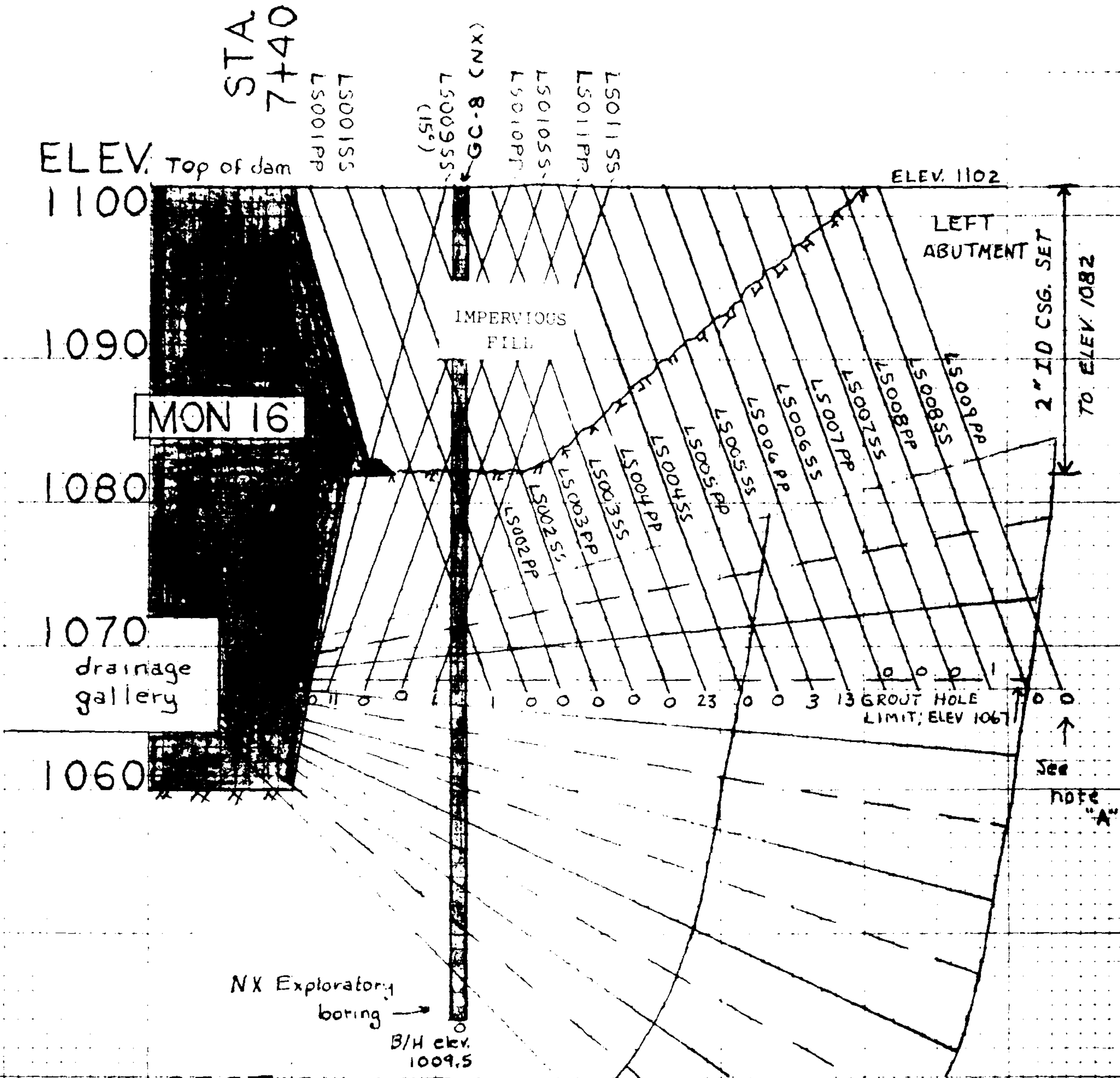
GROUT CURTAIN
GALLERY - LEFT FAN
STA. 7+92.78 - 7+98.00

Scale: 1" = 10'

EXHIBIT NO. 11-10



PLAN VIEW
SCALE 1" = 5'



X-SECTION VIEW
FACING UPSTREAM
SCALE 1" = 10'

NOTES:

A. Total bag of cement, rounded to nearest whole number, placed in hole during pressure grouting.

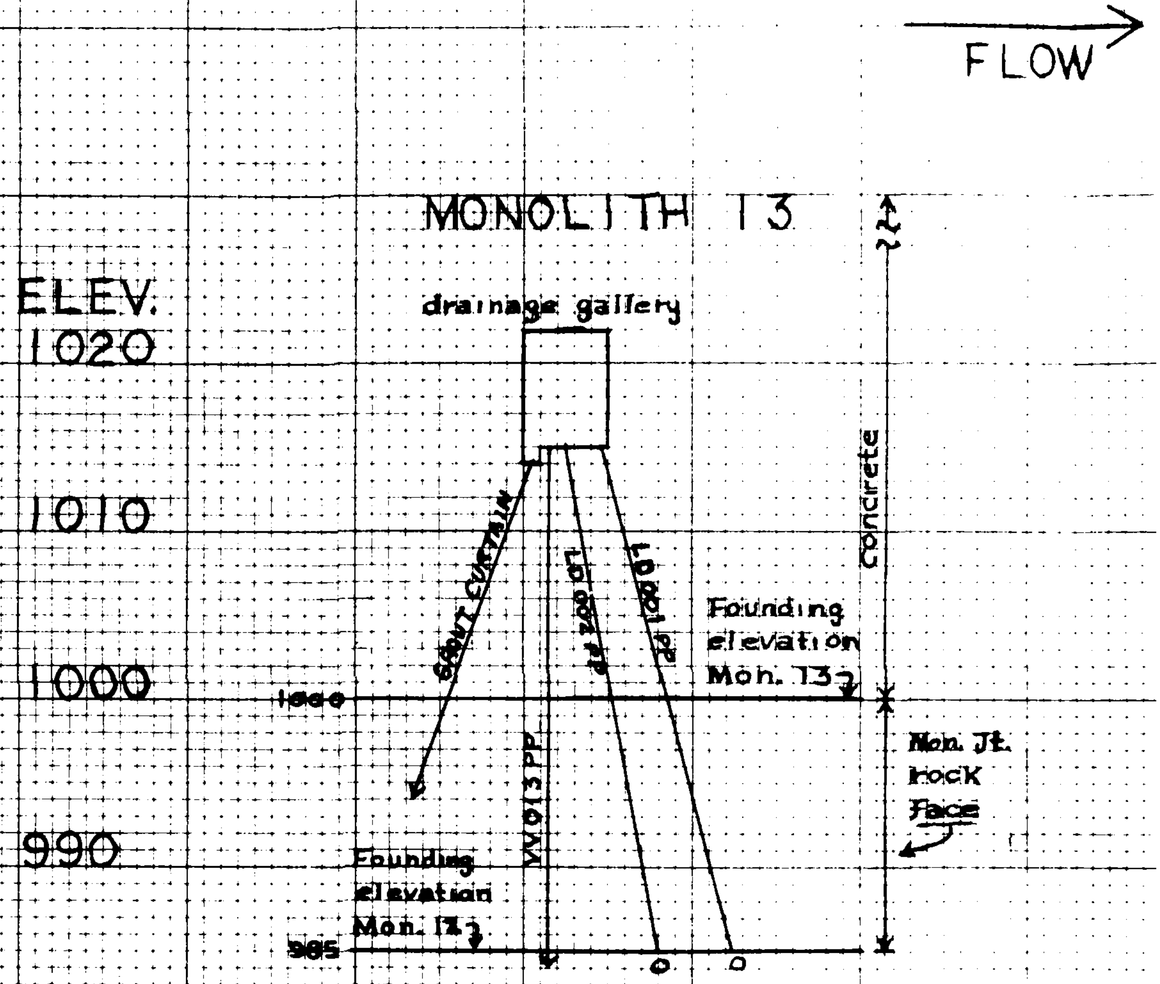
U.S. ARMY, HUNTINGTON DISTRICT
CORPS OF ENGINEERS

FOUNDATION REPORT
WEST FORK RIVER, WEST VIRGINIA
STONEWALL JACKSON DAM

GROUT CURTAIN
SURFACE - LEFT ABUTMENT
STA. 7+40.90 - 7+78.50

Scale: AS SHOWN

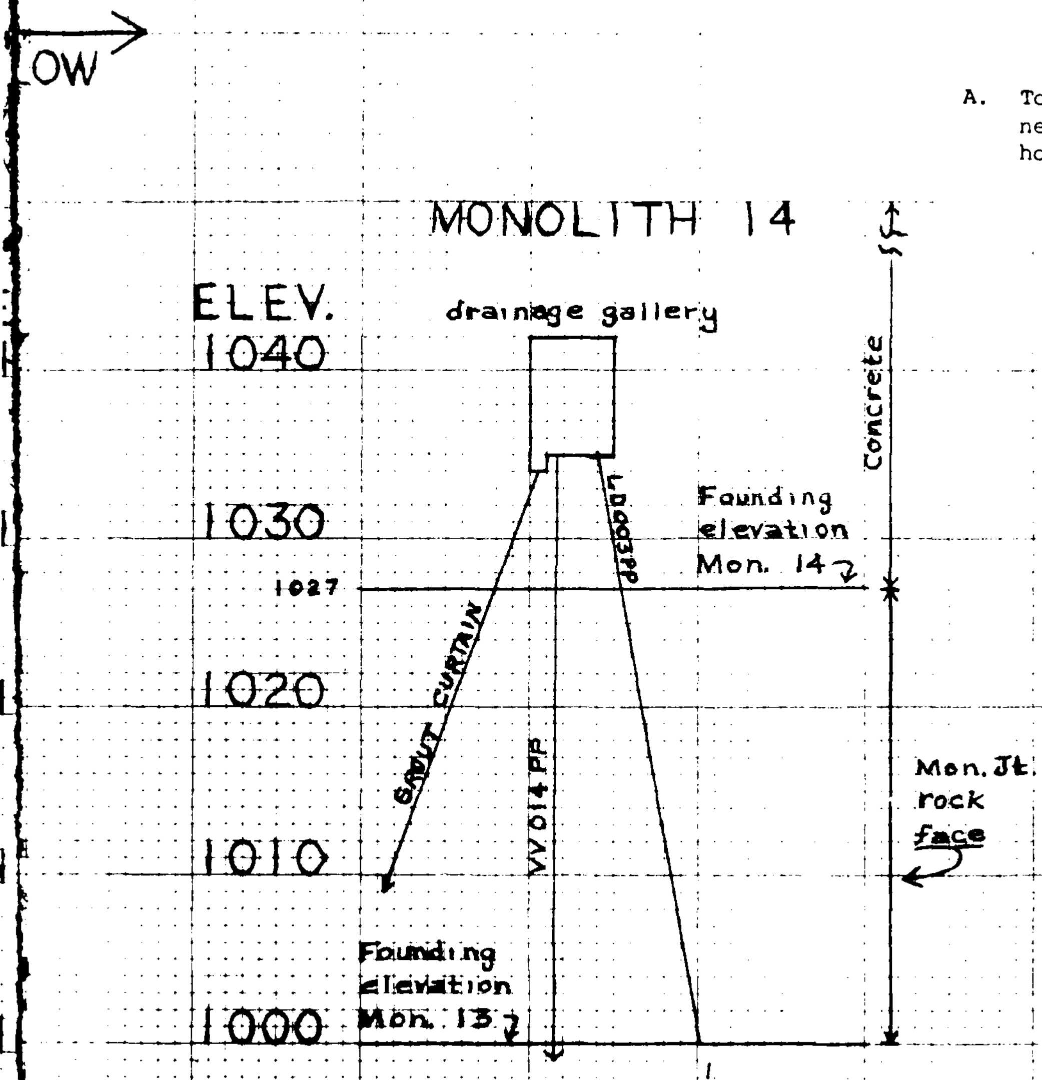
EXHIBIT NO. 11-11



X-SECTION VIEW
STA 5+81
HOLES LD001PP &
LD002PP

NOTES:

A. Total bag of cement, rounded to nearest whole number, placed in hole during pressure grouting.



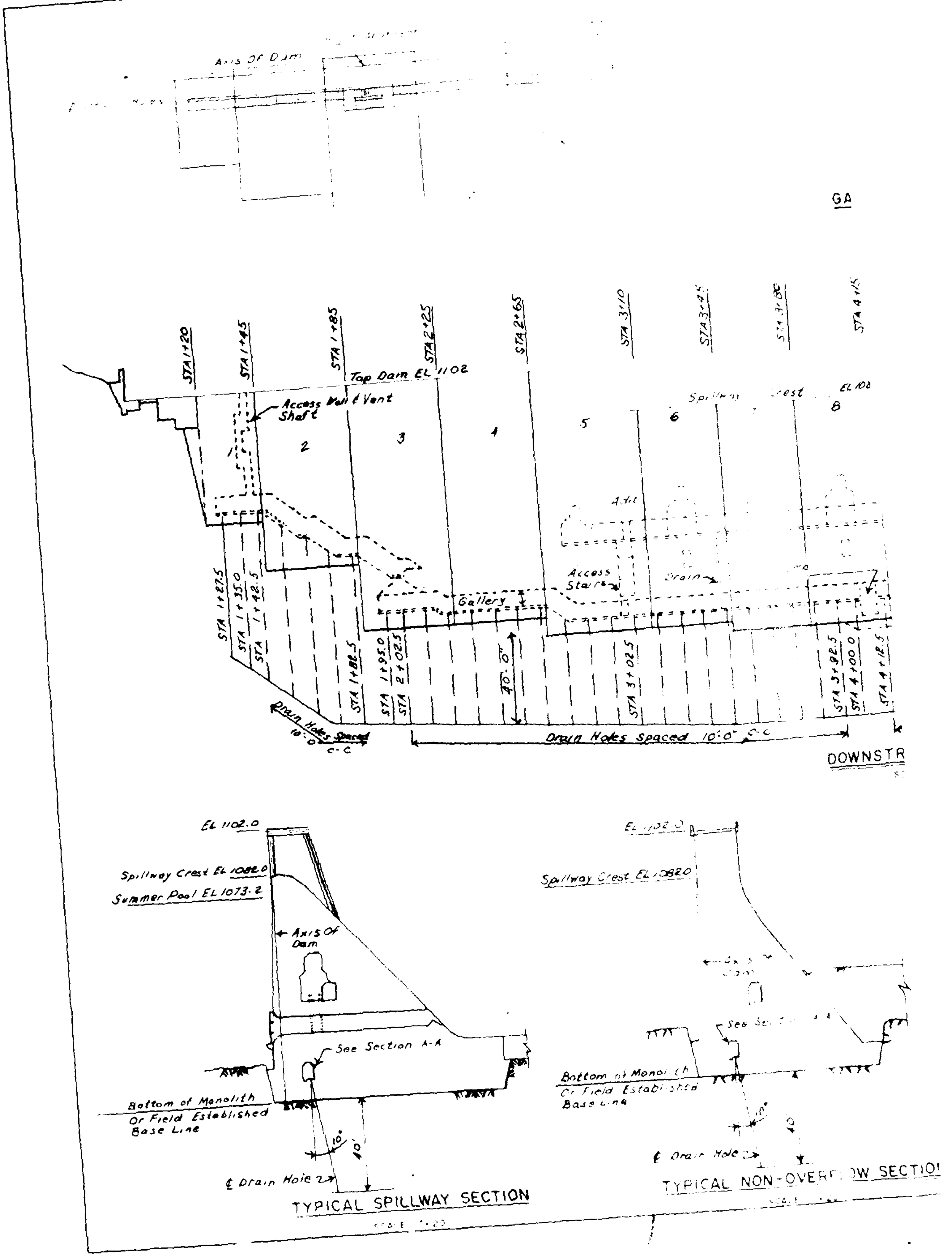
X-SECTION VIEW
STA 6+22.25
HOLE LD003PP

U.S. ARMY, HUNTINGTON DISTRICT
CORPS OF ENGINEERS
FOUNDATION REPORT
WEST FORK RIVER, WEST VIRGINIA
STONEWALL JACKSON DAM

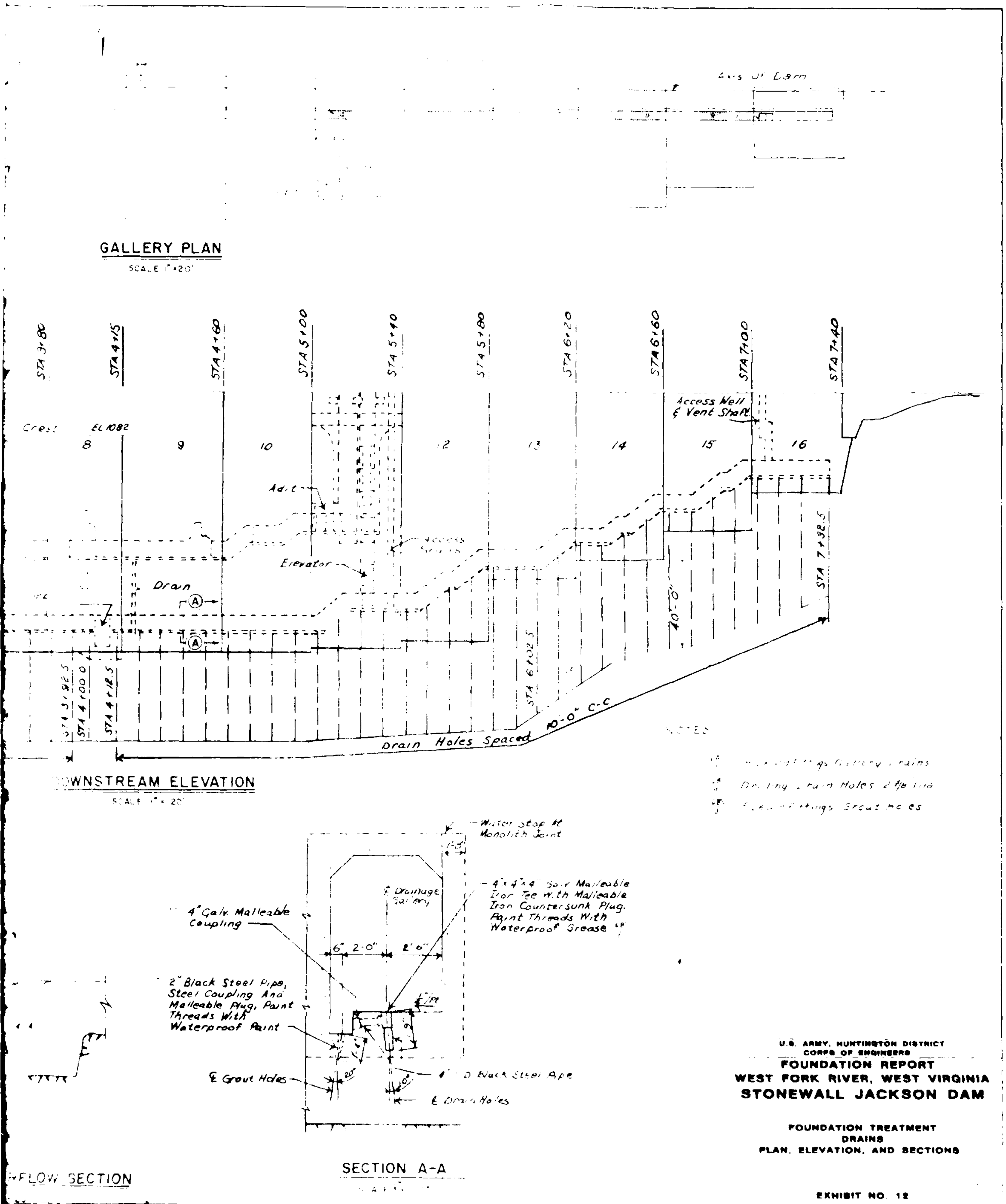
GROUT CURTAIN
GALLERY - MISC. HOLES
STA. 5+81.00 - 6+22.25

Scale: 1" = 10'

EXHIBIT NO. 11-12



Axis Of Dam
GA
STA 1+20
STA 1+45
STA 1+85
STA 2+25
STA 2+65
STA 3+10
Top Dam EL 1102
Access Well & Vent Shaft
Spillway Crest
1
2
3
4
5
6
8
Access Stairs
Drain
Gallery
STA 1+27.5
STA 1+35.0
STA 1+42.5
STA 1+88.5
STA 1+95.0
STA 2+02.5
40'-0"
STA 3+02.5
STA 3+92.5
STA 4+00.0
STA 4+12.5
Drain Holes Spaced 10'-0" C-C
Drain Holes Spaced 10'-0" c-c
DOWNSTR
EL 1102.0
Spillway Crest EL 1082.0
Summer Pool EL 1073.2
Axis Of Dam
See Section A-A
Bottom of Monolith
Or Field Established Base Line
10°
40'
℄ Drain Hole 2
TYPICAL SPILLWAY SECTION
Spillway Crest EL 1082.0
Bottom of Monolith
Or Field Established Base Line
℄ Drain Hole
TYPICAL NON-OVERF OW SECTIO

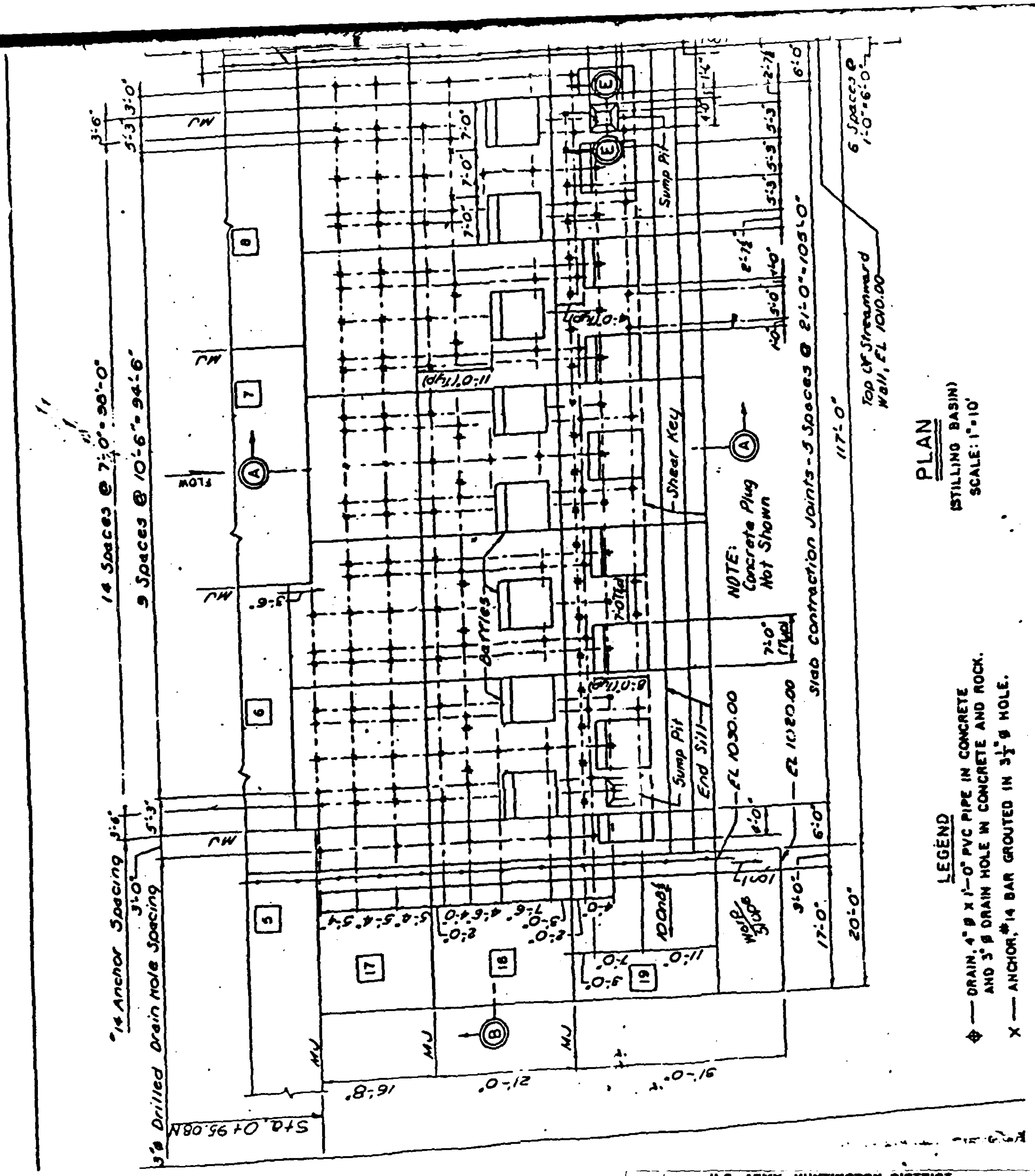


U.S. ARMY, HUNTINGTON DISTRICT
CORPS OF ENGINEERS

FOUNDATION REPORT
WEST FORK RIVER, WEST VIRGINIA
STONEWALL JACKSON DAM

FOUNDATION TREATMENT
DRAINS
PLAN, ELEVATION, AND SECTIONS

EXHIBIT NO. 12

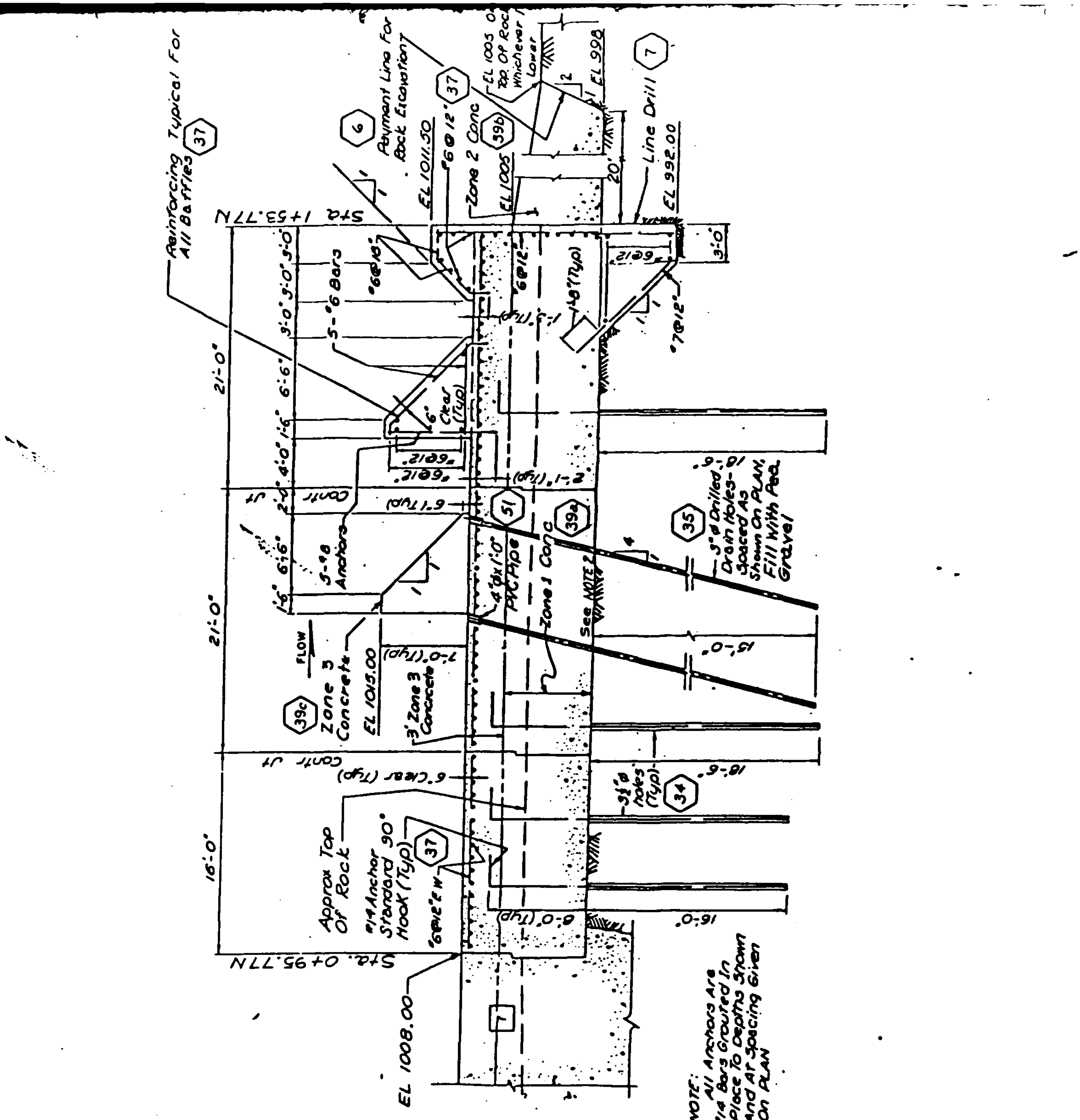


U.S. ARMY, HUNTINGTON DISTRICT
CORPS OF ENGINEERS

FOUNDATION REPORT
WEST FORK RIVER, WEST VIRGINIA
STONEWALL JACKSON DAM

FOUNDATION DRAINS
STILLING BASIN
PLAN VIEW

EXHIBIT NO. 12-1



U.S. ARMY, HUNTINGTON DISTRICT
CORPS OF ENGINEERS

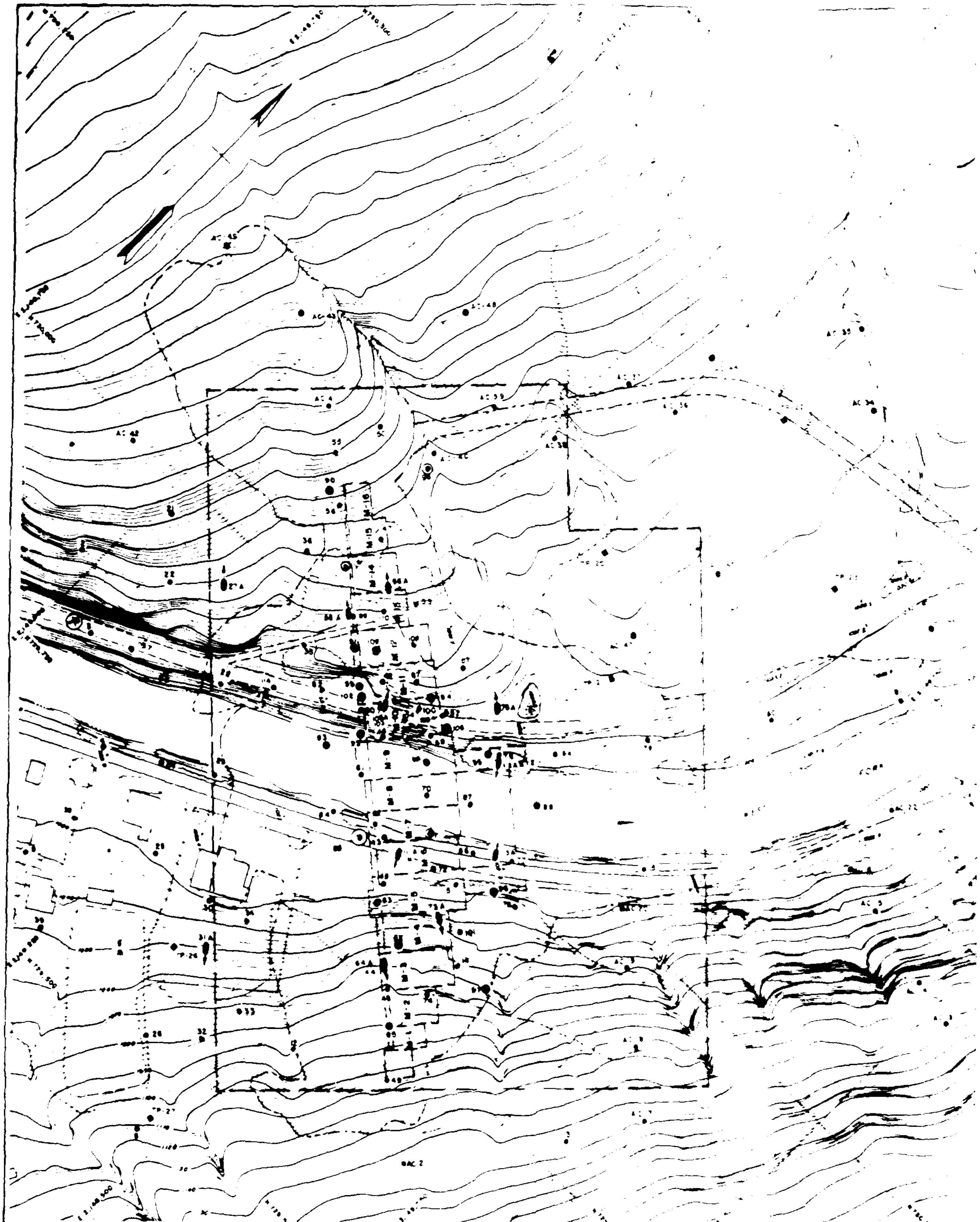
FOUNDATION REPORT

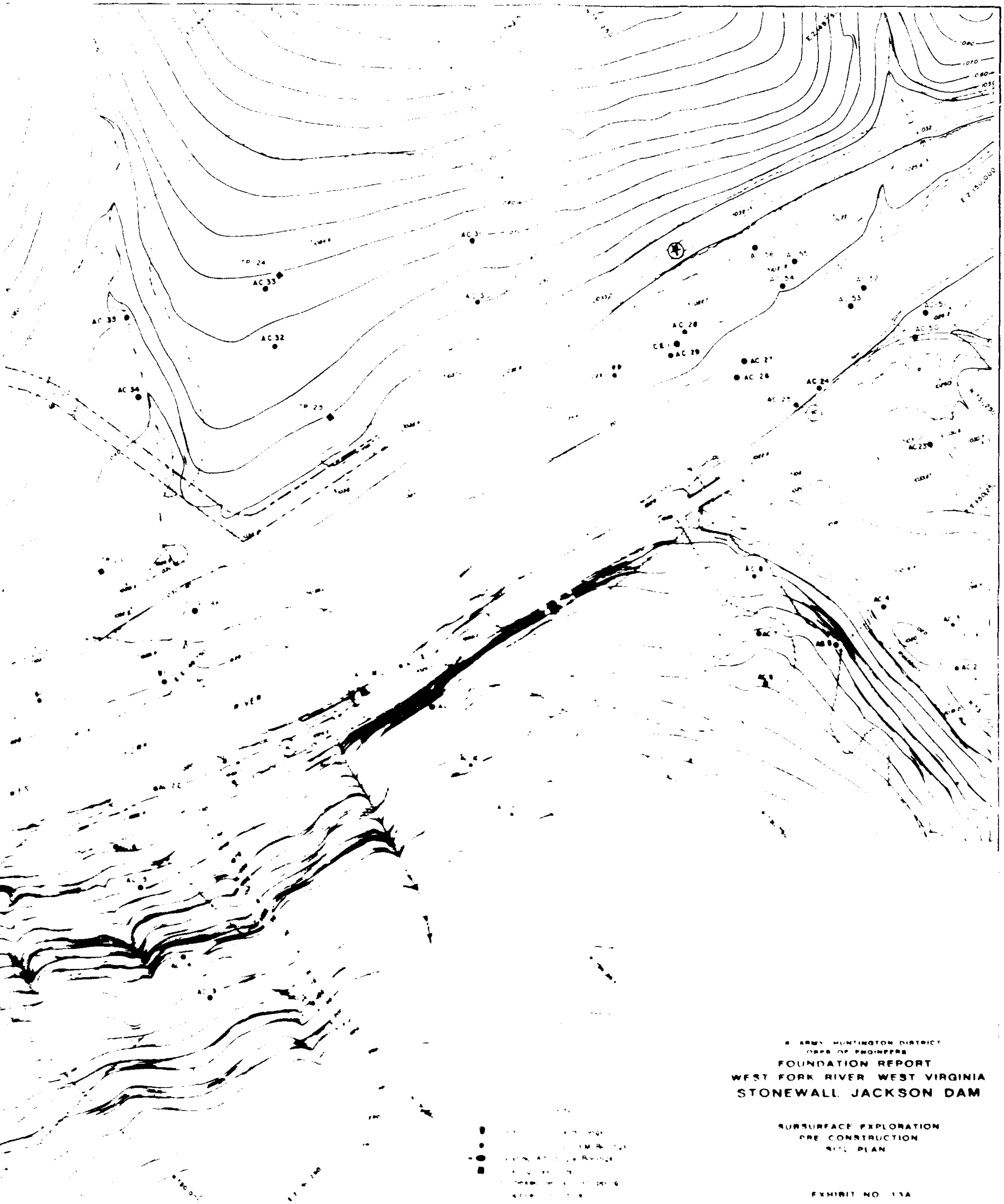
WEST FORK RIVER, WEST VIRGINIA

STONEWALL JACKSON DAM

FOUNDATION DRAINS
STILLING BASIN
X-SECTION VIEW

EXHIBIT NO. 12-2





ARMY HUNTINGTON DISTRICT
CORPS OF ENGINEERS
FOUNDATION REPORT
WEST FORK RIVER WEST VIRGINIA
STONEWALL JACKSON DAM

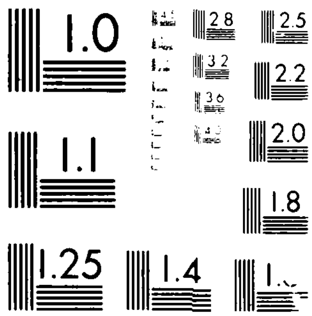
SUBSURFACE EXPLORATION
PRE CONSTRUCTION
SITE PLAN

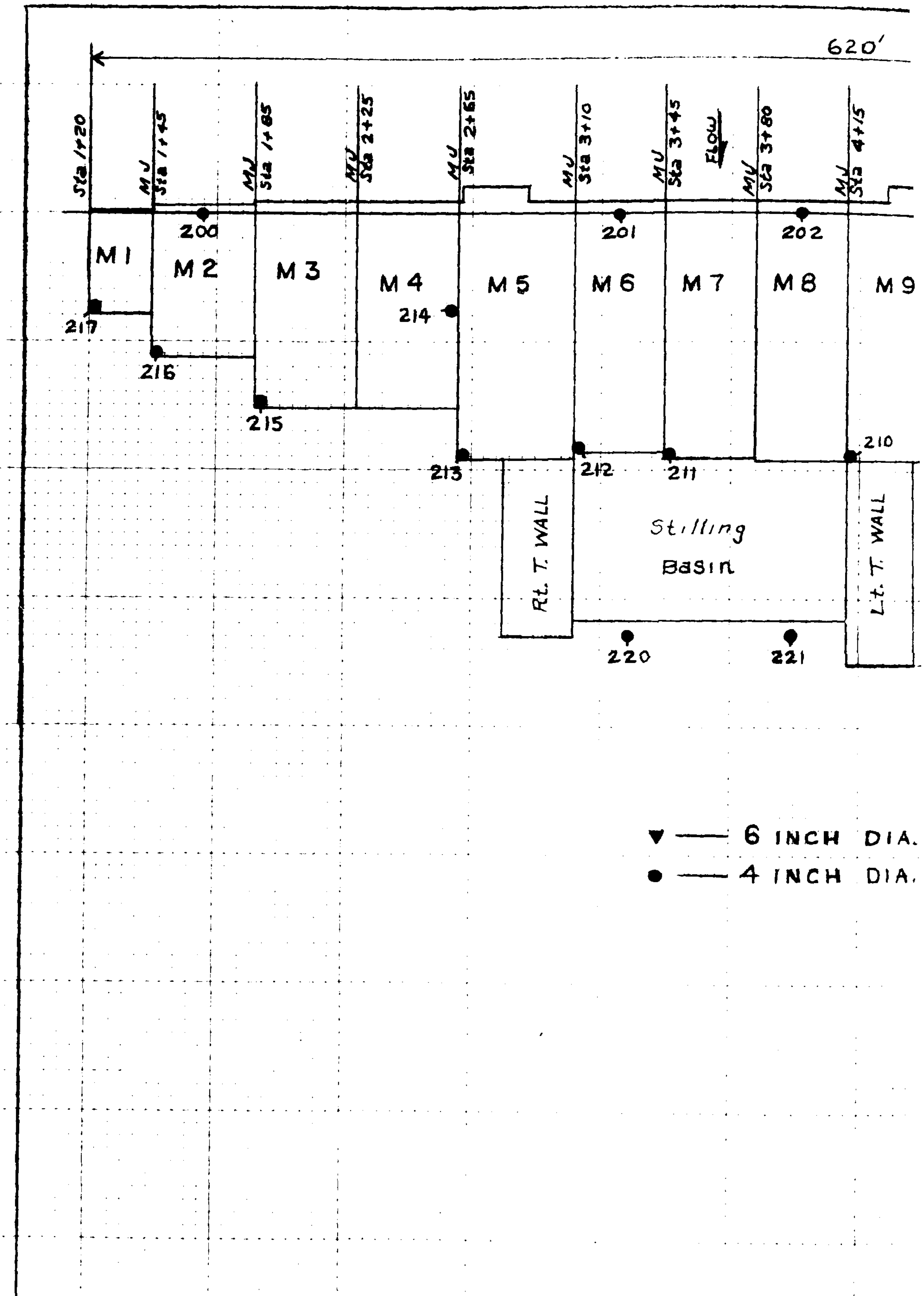
EXHIBIT NO. 13A

AD-A191 144 FOUNDATION REPORT ON STONEWALL JACKSON DAM WEST FORK RIVER BASIN WESTON W... (U) CORPS OF ENGINEERS HUNTINGTON WV HUNTINGTON DISTRICT D NUGEN 21 DEC 87 6/6

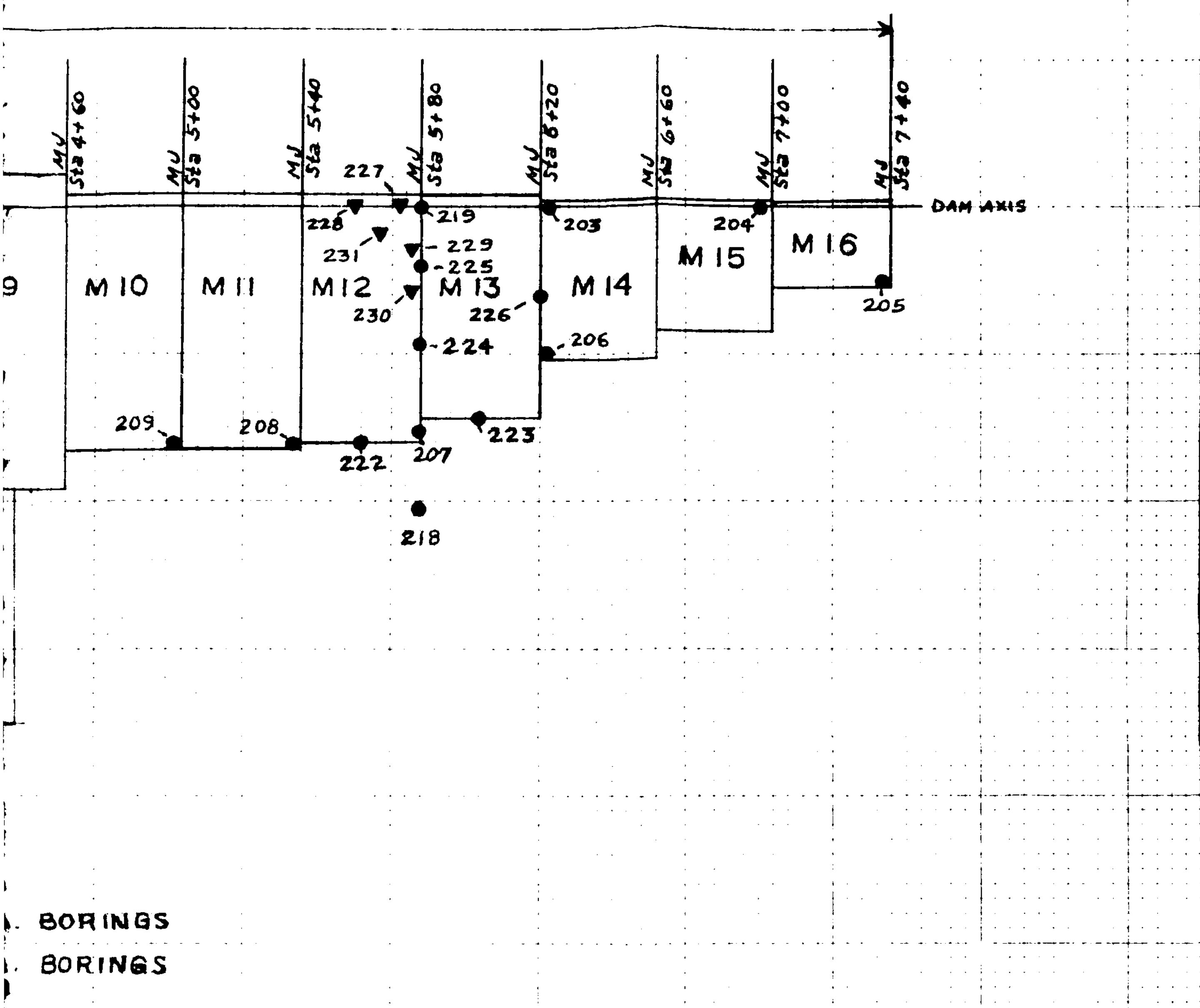
UNCLASSIFIED DACW59-83-C-0053 F/G 13/2 NL

END
DATE
FILMED
5 88
DTIC


1.0
2.8
2.5
3.2
2.2
3.6
2.0
1.1
1.8
1.25
1.4



620'
Sta 1+20
MJ Sta 1+45
MJ Sta 1+85
MJ Sta 2+25
MJ Sta 2+65
MJ Sta 3+10
MJ Sta 3+45
Flow
MJ Sta 3+80
MJ Sta 4+15
200
201
202
M1
M2
M3
M4
M5
M6
M7
M8
M9
217
216
215
214
213
212
211
210
Rt. T. WALL
Stilling Basin
Lt. T. WALL
220
221
6 INCH DIA.
4 INCH DIA.



U.S. ARMY, HUNTINGTON DISTRICT
CORPS OF ENGINEERS

FOUNDATION REPORT
WEST FORK RIVER, WEST VIRGINIA
STONEWALL JACKSON DAM

SUBSURFACE EXPLORATION
DURING CONSTRUCTION

Scale: 1" = 50'

EXHIBIT NO. 13B

2

SECTION X

APPENDIX

10-3 GRAPHIC LOGS OF BORINGS

A. Statistical Data

B. Logs

EXPLORATORY BORINGS
STATISTICAL DATA

SUBJECT
4" DIAMETER EXPLORATORY DRILLING DURING CONSTRUCTION - BID ITEM 67

SUBCONTRACTOR - CROWN PRESSURE GROUTING CO.

17 JANUARY 1984 - 12 APRIL 1984

HOLE No.	LOCATION	ELEV. T/H	ELEV. START CORING	NON-CORING FOOTAGE	ELEV. B/H	4" DIA. CORING FOOTAGE	DATE COMPLETED
200	Mon. 2 on Dam Axis	1062.5	1040.0	22.5	1010.0	30.0	2-08-84
201	Mon. 6 on Dam Axis	1005.8	1005.8	0.0	979.0	26.8	2-20-84
202	Mon. 8 on Dam Axis	1002.4	1002.4	0.0	975.0	27.4	2-23-84
203	Mon. 14 on Dam Axis	1042.5	1033.0	9.5	1008.0	25.0	3-08-84
204	Mon. 15 on Dam Axis	1084.8	1055.0	29.8	1030.0	25.0	4-03-84
205	Mon. 16 D/S, Lt. Corner	1092.1	1073.0	19.1	1048.0	25.0	4-12-84
206	Mon. 13/14 Joint, D/S	1041.3	1033.0	8.3	1008.0	25.0	3-12-84
207	Mon. 12 D/S, Lt. Corner	1039.2	1005.0	34.2	970.0	35.0	3-14-84
208	Mon. 11 D/S, Lt. Corner	1007.0	1002.0	5.0	970.0	32.0	4-09-84
209	Mon. 10 D/S, Lt. Corner	1037.3	1000.0	37.3	970.0	30.0	3-06-84
210	Mon. 9 D/S, Rt. Corner	1000.5	1000.5	0.0	970.0	30.5	2-24-84
211	Mon. 7 D/S, Rt. Corner	1003.9	1003.9	0.0	972.0	31.9	2-21-84
212	Mon. 6 D/S, Rt. Corner	1004.4	1004.4	0.0	979.0	25.4	2-22-84
213	Mon. 5 D/S, Rt. Corner	1013.9	1013.9	0.9	979.0	34.0	2-14-84
214	Mon. 4/5 Near Joint	1011.7	1011.7	0.0	979.0	32.7	2-15-84
215	Mon. 3 D/S, Rt. Corner	1055.9	1012.0	43.9	987.0	25.0	2-03-84
216	Mon. 2 D/S, Rt. Corner	1081.6	1040.0	41.6	1015.0	25.0	1-31-84
217	Mon. 1 D/S, Rt. Corner	1094.4	1060.0	34.4	1035.0	25.0	2-09-84
	BORINGS ADDED DURING INITIAL PROGRAM						
218	Mon. 12 25' D/S of Hole #207	1039.5	1039.5	0.0	970.0	69.5	3-29-84
219	Mon. 12/13 Joint on Axis	1037.7	1023.0	14.7	970.0	53.0	3-19-84
220	5' D/S of Stilling Basin, Rt. Side	1000.6	1000.6	0.0	980.0	20.6	3-20-84
221	5' D/S of Stilling Basin, Lt. Side	999.4	999.4	0.0	980.0	19.4	3-22-84

EXPLORATORY BORINGS
STATISTICAL DATA

SUBJECT
ADDITIONAL 4" DIAMETER EXPLORATORY DRILLING DURING CONSTRUCTION - BID ITEM 67

SUBCONTRACTOR - CROWN PRESSURE GROUTING CO.

17 SEPTEMBER 1984 - 11 OCTOBER 1984

HOLE No.	LOCATION	ELEV. T/H	ELEV. START CORING	NON-CORING FOOTAGE	ELEV. B/H	4" DIA. CORE FOOTAGE	DATE COMP.
222	Mon. 12 D/S Middle	1038.2	1005.0	33.2	980.0	25.0	9-27-84
223	Mon. 13 D/S Middle	1040.3	1030.0	10.3	970.0	60.0	10-04-84
224	Mon. 12/13 Joint	1039.6	1020.0	19.6	985.0	35.0	9-19-84
225	Mon. 12/13 Joint	1039.2	1020.0	19.2	985.0	35.0	9-24-84
226	Mon. 13/14 Joint	1040.0	1030.0	10.0	985.0	45.0	10-09-84

6" DIAMETER EXPLORATORY DRILLING DURING CONSTRUCTION (MOD. NO. P00052)

SUBCONTRACTOR - B. H. MOTTS & SONS

10 MAY 1985 - 14 MAY 1985

HOLE No	LOCATION	ELEV. T/H	ELEV. B/H	6" DIA. CORE FOOTAGE	DATE COMP.		
227	Mon. 12 Sta 5+73.5 Dam Axis	984.6	959.4	25.2	5-14-85		
228	Mon. 12 Sta 5+57.8 Dam Axis	984.4	959.5	25.9	5-11-85		
229	Mon. 12 Sta 5+77.5 16.8' D/S of Axis	983.8	961.7	22.1	5-13-85		
230	Mon. 12 Sta 5+76.5 27.2' D/S of Axis	984.5	963.5	21.0	5-13-85		
231	Mon. 12 Sta 5+66 9.8' D/S of Axis	983.9	961.4	22.5	5-14-85		

ORN FORM 1137

EXPLORATORY BORINGS
STATISTICAL DATA

3-INCH DIAMETER EXPLORATORY DRILLING - GROUT CURTAIN

SUBCONTRACTOR - PENNSYLVANIA DRILLING CO.

24 MARCH 1986 - 30 MAY 1986

Hole No.	Location	Mono. No.	Elev. T/H	Elev. T/R	Elev. B/H	Date Completed	
GC-1	1+11.50	Rt. Abut.	1102.0	1081.0	995.9	5-08-86	
GC-2	1+62	2	1039.0	1020.2	961.0	4-25-86	
GC-3	4+56	8	993.7	984.0	931.5	5-15-86	
GC-4	5+70	12	1007.5	981.6	930.6	5-13-86	
GC-5	6+17	13	1032.5	996.8	945.1	5-12-86	
GC-6	1+98.75	3	1005.0	995.6	994.5	5-27-86	
GC-7	2+07.05	3	1005.0	995.6	994.5	5-27-86	
GC-8	7+51.50	Lt. Abut.	1102.0	1082.0	1009.5	5-30-86	

ORH FORM
7 DEC 44 437

Hole No. 200

DRILLING LOG	DIVISION: Ohio River	INSTALLATION: Pittsburgh District	SHEET 1 OF 2 SHEETS

1. PROJECT: STONEWALL JACKSON DAM	10. SIZE AND TYPE OF BIT: 4" ID Diamond
2. LOCATION (Coordinates or Station): MONO 2 - Middle of Upstream	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL
3. DRILLING AGENCY: Crown Pressure Grouting Co.	12. MANUFACTURER'S DESIGNATION OF DRILL: Sprague & Henwood 40 C
4. HOLE NO. (As shown on drawing title and file number): DWG 0372, 200 U1 18/21	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED – UNDISTURBED –
5. NAME OF DRILLER: R. Haddix	14. TOTAL NUMBER CORE BOXES: 5
6. DIRECTION OF HOLE: [X] VERTICAL [ ] INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER: 1034.4
	16. DATE HOLE: STARTED 31 Jan 84; COMPLETED 8 Feb 84
7. THICKNESS OF OVERBURDEN: Wasted Rock 22.2	17. ELEVATION TOP OF HOLE: 1062.5
8. DEPTH DRILLED INTO ROCK: Core 29.3	18. TOTAL CORE RECOVERY FOR BORING: %
9. TOTAL DEPTH OF HOLE: 51.5	19. SIGNATURE OF INSPECTOR: Dave Nugen

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
1062.5			Rock not Sampled between Elev. 1062.5 and 1040			DAVEY AIR DRILL, 6 1/4-inch OD Tricone Bit
1040.3			START CORING			
1039.4			CLAYSTONE, soft, silty to sandy, gr to stained br	100%		1040.3-1039.7 high angle stained wd. fracture
			SANDSTONE, soft to moderately hard, silty, fine hrained, stained olive brown	0 Loss; 92%; L 0.2	Box 1	1039.4 horz sta. parting; 1039.7-1037.4 open sta. wide partially br. Clay filled vert jt.; wide stained bedding planes @ 1038,1037.8 1036.9,1036.5,1036, 1034.5
1032.9					1033.1	
1031.9			SILTSTONE, mod hard, very bkn. sta br. w/br clay coa			Lost drill water 1036.5
1030.5			SANDSTONE, silty, fine gra, gray, sta bro, mod. hard		Box 2	1033.8-1032.9 very bkn. with brown clay
1029.2			CLAYSTONE, soft, very bkn. br. weathered	100%		1033.1-1032.9 Loss; 1031.9-1029.3 very bkn,
			SANDSTONE, silty, fine to med. grained, gray and stained br. mod. hard, occ. very broken	100%	1026.6	wide, high angle joint with clayey coatings; 1029.3-1029.2 gray slightly weathered CLS
1023.1					Box 3	1025.4 high angle stained open joint with trace CL coating
1022.0			SILTSTONE, sandy, mod hard, med. gr., w/cls, soft to mod. hard, from 1022.5 to 1023.0			1025.0-1023.9 stained leached weathered
			SANDSTONE/SILTSTONE, mod. hard, med. gray, SS fine grained, sls, calc. incl., occ. slk partings	100%	1019.6	1024.9-1024.5, 45° open joint
1017.1			CLAYSTONE, silty, mod. hard med. gr., mottled to 1015. occ high angled slk part. scattered calc. incls.	100%	Box 4	1024.4-1024.1 broken with trace brown clayey coa.; 1023.7-1023.4 irregular high angle stained open joint.
1014.0			SILTSTONE/CLAYSTONE		1014.6	1023.1 - stained harz. parting.

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE | PROJECT | HOLE NO

DRILLING LOG (Cont Sheet) ELEVATION TOP OF HOLE

Hole No. 200

PROJECT Stonewall Jackson Dam | INSTALLATION Pittsburgh District | SHEET 2 OF 2 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
1011.0	51.5		mod. hard, gray, sandy zone 1014 to 1012.7	100	Box 5 1011.0	1023.1-1022.1 sta. high angle bkn jts. 1022. Found Elev. Mono 2
			BOTTOM OF HOLE 1.0 core left in Hole			1020.7 low angle slick parting slick partings @ 1019, 1018.4, 1017.5 1017.4-1017.1 high angle fract's, parted along slick fractures @ 1016.6 1016.3, 1015.5 - 1014.8 1016, iron nodules 1014.6-1014.0 overcored with gray clayey coating. 1013.7-irregular slick partings.

Hole No. 201

DRILLING LOG	DIVISION Ohio River	INSTALLATION Pittsburgh District	SHEET 1 OF 2 SHEETS

1. PROJECT: Stonewall Jackson Dam	10. SIZE AND TYPE OF BIT
2. LOCATION (Coordinates or Station): Mono 6 - UPST. Center	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL
3. DRILLING AGENCY: Crown Pressure Grouting Co.	12. MANUFACTURER'S DESIGNATION OF DRILL: Sprague & Henwood 40C
4. HOLE NO. (As shown on drawing title and file number): 201	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED --- UNDISTURBED ----
5. NAME OF DRILLER: R. Haddix	14. TOTAL NUMBER CORE BOXES: 4
6. DIRECTION OF HOLE: [X] VERTICAL [ ] INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER: Artesian Flow
	16. DATE HOLE: STARTED 16 Feb 84; COMPLETED 20 Feb 84
7. THICKNESS OF OVERBURDEN: 0	17. ELEVATION TOP OF HOLE: 1005.8
8. DEPTH DRILLED INTO ROCK: 26.9	18. TOTAL CORE RECOVERY FOR BORING: 95 %
9. TOTAL DEPTH OF HOLE: 26.9	19. SIGNATURE OF INSPECTOR: Dave Nugen

ELEVATION 1005.8 (a)	DEPTH (b)	LEGEND (c)	CLASSIFICATION OF MATERIALS (Description) (d)	% CORE RECOVERY (e)	BOX OR SAMPLE NO. (f)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) (g)
1005.6			SHALE, carb, silty	55		
1002.9			COAL, REDSTONE, black, blocky, pyritic		Box 1	
1001.5			CLAYSTONE, mod. hard, silty, sandy, gr. carb.	80		1002.9 Open contact 1001.4 - 1001.5 mech. bkn. with 0.2 loss
1000.6			SILTSTONE, mod hard, med. gray, sandy, silty	90		
1000.0			SANDSTONE, mod. hard, fine grain silty		998.9	
998.8			SILTSTONE, mod. hard med. gr., sa w/bk. sil incl			
998.0			SILTSHALE, mod. hard, gray	100	Box 2	998.1 - 998.0 bln. on sli wd. claystone lam.
995.5			SANDSTONE, mod. hard, med. gr., fine grained, silty inter bd w/shaly CLS			994.5 - 993.8 clayshale med hard, dk. gray
993.3			SILTSTONE, soft, med gr. sandy w/occ. CLSH		991.9	
991.2			CLAYSHALE, mod. hard, dk. gr. sandy, calc. incl	100		Artesian Flow begins somewhere between 989.4 and 985.3 in run 6
990.8			SILTSTONE, mod. hard, gr.		Box 3	
988.0			SANDSTONE, hard, med, gr. fine grain, occ. mech-DF's, silty			
987.8			LIMESTONE, hard gray	100	985.0	988-987.8 trace clayey coatings on partings.
987.2			SILTSHALE, mod hard, gr.			
986.4			SANDSTONE, hard, med., gr. fine grained, silty		Box 4	987.7 Found Elevation for Mono 6
985.9			SILTSTONE, mod. hard, cl, gr			986.2 non wd. parting filled with cuttings.
983.4			SANDSTONE, hard, silty, fine grained, gray	100		983.4 low angle
979.4			SILTSHALE, mod. hard, med., gr., sandy, occ. slk, w/ scat. brown incl.			Non-stained contact. 480.3 slick surface @ mech. parting
979.2			LIMESTONE, hard, gray			979.4-974.2 tight IDF
978.9			SILTSTONE, mod. hard, dk. gr., sandy, shaly	100	978.9	
						SLIGHT ARTESIAN FLOW UPON COMPLETION.

ENG FORM 1836 PROJECT HOLE NO.

Hole No. 202

DRILLING LOG

- DIVISION: Ohio River
- INSTALLATION: Pittsburgh District
- SHEET OF 1 SHEETS
- 1. PROJECT: Stonewall Jackson Dam
- 2. LOCATION (Coordinates or Station): Mono 8-upst. Centerline
- 3. DRILLING AGENCY: Crown Pressure Grouting
- 4. HOLE NO. (As shown on drawing title and file number): 202
- 5. NAME OF DRILLER: R. Haddix
- 6. DIRECTION OF HOLE: [X] VERTICAL [ ] INCLINED ____ DEG. FROM VERT.
- 7. THICKNESS OF OVERBURDEN: 0
- 8. DEPTH DRILLED INTO ROCK: 27.5
- 9. TOTAL DEPTH OF HOLE: 27.5
- 10. SIZE AND TYPE OF BIT: 4-inch Diamond
- 11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL
- 12. MANUFACTURER'S DESIGNATION OF DRILL: Sprague & Henwood 40 C
- 13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED – UNDISTURBED –
- 14. TOTAL NUMBER CORE BOXES: 4
- 15. ELEVATION GROUND WATER: Artesian Flow
- 16. DATE HOLE: STARTED 22 Feb 84; COMPLETED 23 Feb 84
- 17. ELEVATION TOP OF HOLE: 1002.4
- 18. TOTAL CORE RECOVERY FOR BORING: 98.5 %
- 19. SIGNATURE OF INSPECTOR: Dave Nugen

ELEVATION 1002.4 (a)	DEPTH (b)	LEGEND (c)	CLASSIFICATION OF MATERIALS (Description) (d)	% CORE RECOVERY (e)	BOX OR SAMPLE NO. (f)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) (g)
1000.6			CLAYSTONE, soft, gray, badly weathered to 1001.3	94.4		Loss 1002.4-1002.3
998.8			SANDSTONE, silty, fine grain gr. mod hard, occ. wd part.	85	1	1001.3-1001.0, silty SS w/ high angle open joint.
998.1			CLAYSTONE, soft to mod. hard, med gray	100		1000.6-1000.3 - loss
997.5			SANDSTONE, silty, fine grained, mod hard, gray		995.3	1000.2-1000.0, open high angle frac.
996.6			SILTSTONE, mod. hard, med. gr., w/occ. incl.			
993.1			SANDSTONE, silty, fine grain, mod hard to hard, gray, part along silty lam	100	2	999.4 - core spin 998.1 - irregular contact
991.2						
990.6			SILTSHALE, mod hard, dk. gr. w/cal. incl., pyrite			Artesian flow after run 3
998.5					998.8	
987.0			CLAYSTONE, soft, gray slk, wd., cal. incl.	100		985.4-985.3 broken 985.2 low angle irreg. parting.
			SANDSTONE, silty, fine grained, hard, med gr. micaceous		3	985.0 found El. Mono 8
			SILTSTONE, sandy, mod. hard, med. gr. shaly	100		982.8-982.3 silt shale incl.
981.7					981.9	
			SANDSTONE, silty, fine grained, hard, med. gray			982.8-982.6 - 45° calc. zone w/smooth open slick pyrite parting
979.0			SILTSTONE, shaly, mod, hard, gr w/calc incl.	100	4	982.5-982.3 mech bk.
978.0			CLAYSTONE, dk. gr. skl., mod. hard			978.2-978.0 bkn. 977.8-977.0 sandy zo.
974.9			SILTSTONE, mod. hard, shaly, dark gr.	100		974.9,45° slick partings
						BOTTOM OF HOLE Heavy artesian flow upon completion (15-20 gpm)

ENG FORM 1836   PROJECT   HOLE NO.

Hole No. 203

DRILLING LOG	DIVISION Ohio River	INSTALLATION Pittsburgh District	SHEET [illegible] OF [illegible] SHEETS

1. PROJECT: Stonewall Jackson Lake Dam	10. SIZE AND TYPE OF BIT: 4-inch ID Diamond
2. LOCATION (Coordinates or Station): Mono. 14 Upst. Rt. Corner	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL
3. DRILLING AGENCY: Crown Pressure Grouting Co.	12. MANUFACTURER'S DESIGNATION OF DRILL: Sprague & Henwood 40C
4. HOLE NO. (As shown on drawing title and file number): 203	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED ---- UNDISTURBED ----
5. NAME OF DRILLER: R. Haddix	14. TOTAL NUMBER CORE BOXES:
6. DIRECTION OF HOLE: [X] VERTICAL [ ] INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER: 1026.8
	16. DATE HOLE: STARTED 29 Feb 84 COMPLETED 3 Mar 84
7. THICKNESS OF OVERBURDEN: Wasted Rock 8.8	17. ELEVATION TOP OF HOLE: 1042.5
8. DEPTH DRILLED INTO ROCK: Core 26.7	18. TOTAL CORE RECOVERY FOR BORING: 99 %
9. TOTAL DEPTH OF HOLE: 35.5	19. SIGNATURE OF INSPECTOR: Dave Nugen

ELEVATION 1042.5 (a)	DEPTH (b)	LEGEND (c)	CLASSIFICATION OF MATERIALS (Description) (d)	% CORE RECOVERY (e)	BOX OR SAMPLE NO. (f)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) (g)
1033.7			Rock Not Sampled			Drilled with Davey Air Drill and Tricone Roller Bit to 1033.7
1012.9			SANDSTONE, hard, fine to med. grained, med. gray, micaceous, occ. cross bedded. stained along horz. sl. lam. @ 1032.9 CLAYSTONE, lam 1031.8-1031.6 high angle open joint 1031.7-1030.9 slight angular stained parting 1031.[illegible] 45° open joint [illegible]-1030.7 stained open vertical joint 1030.9-1029.8 1025.6-1025.[illegible] high ang. open joint w red-br. thin clay infilling also [illegible] 1024.6-1024.[illegible] 1020.3-1019.8 high ang. open jt. w trace red Cl	100 / 98 / 100 / 100	1 / 1027 / 2 / 1020.[illegible] / 3 / [illegible]	[illegible] Founding Elev. Mon. [illegible] 1020.0-[illegible] high angle open jt w trace clay. [illegible]-[illegible]18.7 stained open irregular vert. jt. [illegible]8.[illegible]-[illegible] small CLAYSTONE [illegible] 1017.4 low angle mech. fract. 1014.0 Founding ELEV. Mon. [illegible]
1011.3			CLAYSTONE, soft-mod. hard. dk. gr, w/ [illegible]ng. SS from 10.2.5-1011.8	100		
1010.3			SANDSTONE, mod. hard, med. gr. fine grained, freq la bd. plane frac's., sl.			
1009.[illegible]			SILTSTONE, soft-mod. hard, clayey, med gray, occ. clay fil. fracs	100	1007.0	
1007.0			SANDSTONE, mod. hard, med. gr., silty, w/CLS/SLS shear zone			1016.[illegible]-1014.6 [illegible] [illegible] sta. [illegible] 1016.[illegible]-[illegible]4.4 parting along high-ang. fract. 1013.0 [illegible] small dk gr. CLS. incl. [illegible] 1012.[illegible] 1012.9 low ang. part. 1012.5 bkn. sl[illegible]k. part. 1011.8-101[illegible].[illegible] broken sheared SS SLS zone, soft, clayey 1010.3 [illegible] gr. [illegible] contact. 1010.2-1009.[illegible] bkn. shear 1008.9-1008.[illegible] [illegible] CS shear w SLS fracs & [illegible] incl., dense recmt. [illegible] base 1008.[illegible]-1007.4 healed [illegible] [illegible] smooth [illegible]
			Bottom Of Hole			

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE PROJECT HOLE NO

Hole No. 204

DRILLING LOG	DIVISION: Ohio River	INSTALLATION: Pittsburgh District	SHEET 1 OF 2 SHEETS

1. PROJECT: Stonewall Jackson Lake Dam	10. SIZE AND TYPE OF BIT: 4-inch ID Diamond
2. LOCATION (Coordinates or Station): Mono 15 - Upst. LF. Corner	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL
3. DRILLING AGENCY: Crown Pressure Grouting	12. MANUFACTURER'S DESIGNATION OF DRILL: Sprague & Henwood 40C
4. HOLE NO. (As shown on drawing title and file number): 204	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED ---- UNDISTURBED ------
5. NAME OF DRILLER: R. Haddix	14. TOTAL NUMBER CORE BOXES: 4
6. DIRECTION OF HOLE: [x] VERTICAL [ ] INCLINED ____ DEG. FROM VERT	15. ELEVATION GROUND WATER: 1034.3
	16. DATE HOLE: STARTED 2 April 84; COMPLETED 3 April 84
7. THICKNESS OF OVERBURDEN: Wasted Rock 29.5	17. ELEVATION TOP OF HOLE: 1084.8
8. DEPTH DRILLED INTO ROCK: Core 25.9	18. TOTAL CORE RECOVERY FOR BORING: 100 %
9. TOTAL DEPTH OF HOLE: 55.4	19. SIGNATURE OF INSPECTOR: Dave Nugen

ELEVATION 1084.8 (a)	DEPTH (b)	LEGEND (c)	CLASSIFICATION OF MATERIALS (Description) (d)	% CORE RECOVERY (e)	BOX OR SAMPLE NO. (f)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) (g)
1055.3			Not Sampled			Roller Bit
1048.5			INDURATED CLAY, soft - mod. hard, red, slickensided w/occ calcite fil. frac's & occ. SLS nods, sandy. 1052.3-1052.0 high angle frac. w/bkn slk pas.	100 100	1 1048.5	1051.8-1050.0 closely spaced high angle slick partings 1050.5-1050.0 vc broken 1049.4-1048.5 gray w/thin white calcite fil frac's
1046.0			SILTSTONE, mod hard-hard red-gr., clayey-sandy w/calc stages		2	1048.5-1048.1 high angle, healed frac's 1044-1042.9 open wd. stained high angle to vertical joint
1043.5			SANDSTONE, mod hard to hard, med gray, very fine grained calc incl to 1044.5	100		1043.8-1043.2 over-cored
1042.1			CLAYSTONE, mod hard, med, gray, calc incl. calcite healed fract.	100	1041.8	1041.5-1040.8 high angle open sta. joint
1041.0			SANDSTONE, mod hard-hard fine grained, silty gray calc incl.			
1039.7			CLAYSTONE, mod. hard, dk. gr. calc incl & filling		3	
1037.4						
1035.9			SILTSTONE, mod hard, gr.sa.	100	1035.3	CLAYSTONE, dk. gr. calcite fil frac's & incl
			CLAYSTONE, mod hard, sl.			

DRILLING LOG (Cont Sheet)

ELEVATION TOP OF HOLE	Hole No.	PROJECT	INSTALLATION	SHEET
1084.8	204	Stonewall Jackson Dam	Pittsburgh District	2 OF 2 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
1034.2			SILTSTONE, mod. hard, dk. gr. w/calcite healed frac's	100	4	1032.1-1031.9 bkn., slick parting, w/sta. SH. frag's and trace gray clay 1031.2 open calcite
1031.2			CLAYSTONE, mod. hard, dk. gray, w/hard, calc. incl. and filled frac's	100		crystal filled contact 1029.4 sli. calc. coated parting. 0.8 left in hole
1029.4			SANDSTONE, hard, silty, fine grain, gray			
			Bottom Of Hole			

ENG FORM 1836-A JUN 67

Hole No. 205

DRILLING LOG	DIVISION: Ohio River	INSTALLATION: Pittsburgh District	SHEET OF 1 SHEET

1. PROJECT: Stonewall Jackson Lake Dam	10. SIZE AND TYPE OF BIT: 4-inch ID Diamond
2. LOCATION (Coordinates or Station): DNST. LF. Corner of Mono 16	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL
3. DRILLING AGENCY: Crown Pressure Grouting	12. MANUFACTURER'S DESIGNATION OF DRILL: Sprague & Henwood 40C
4. HOLE NO. (As shown on drawing title and file number): 205	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED ---- UNDISTURBED ----
5. NAME OF DRILLER: R. Haddix	14. TOTAL NUMBER CORE BOXES: 4
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER: 1082.1 Completion
7. THICKNESS OF OVERBURDEN: Wasted Rock 18.8	16. DATE HOLE: STARTED 11 April 84 COMPLETED 12 April 84
8. DEPTH DRILLED INTO ROCK: Core 25.7	17. ELEVATION TOP OF HOLE: 1092.1
9. TOTAL DEPTH OF HOLE: 44.5	18. TOTAL CORE RECOVERY FOR BORING: 100
	19. SIGNATURE OF INSPECTOR: Dave Nugen

ELEVATION (a)	DEPTH (b)	LEGEND (c)	CLASSIFICATION OF MATERIALS (Description) (d)	% CORE RECOVERY (e)	BOX OR SAMPLE NO. (f)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) (g)
1092.1			Rock Not Sampled			
1073.3						
1069.8			SILTSTONE, mod. hard, med gr., w/lt. gr. fine grained mod hard SS laminations	100	1	1072.8 open high ang. stained joint low angle stained partings @ 1072.6, 1072.2, 1072.1, 1071.9, 1071.6
1060.4			CLAYSTONE/INDURATED CLAY, soft to mod. hard, slickensided, gray to brownish red 1069.6-1069.4 stained, tkn. 1068.4-1068.1 bkn. slk. 1068.1-1067.8 wd, bkn.	100 100 100	1066.4 2 1059.4	1067.8-1067.0 mottled red & gr. w/carb. streak 1067.8-1067.5 1067.0, slick 45° DF 1065.5, slick low angle DF w/small ironstone incl. 1064.9-1064.4 wd. broken 1063.1-1062.8 slick parting. 1062.1-1061.8 slick med parting 1060.0 founding EL. Mono 16
1057.8			SANDSTONE, hard, med gray, fine to med. grained, silty			
1056.7			SILTSTONE, med. hard, med. gray, w/calc. inclusions	100	3	1059.7-1059.1 non-stained, hi ang. mech. fracture along path of tight frac. extending to 1058.7
1050.1			CLAYSTONE, sandy, mod. hard, slickensided, red w/occ. gray 1052.2-1050.7 closely spaced la, slk. partings	100	1052.6	1056.7 open irregular sli. wd., sli. sta. contact.
1047.6			SILTSTONE, mod. hard, med. gray, w/thin white calcite healed fractures	100	4 1047.6	
			Bottom Of Hole			1050.5-1050.1 calcite filled frac's. 1050.1-1049 8-sandy

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE | PROJECT | HOLE NO.

Hole No. 206

DRILLING LOG	DIVISION: Ohio River	INSTALLATION: Pittsburgh District	SHEET 1 OF 1 SHEETS

1. PROJECT: Stonewall Jackson Lake Dam	10. SIZE AND TYPE OF BIT: 4-inch ID Diamond
2. LOCATION (Coordinates or Station): Mono Jt. 13/14	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL
3. DRILLING AGENCY: Crown Pressure Grouting	12. MANUFACTURER'S DESIGNATION OF DRILL: Sprague & Henwood 40C
4. HOLE NO. (As shown on drawing title and file number): 206	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED ---- UNDISTURBED -----
5. NAME OF DRILLER: R. Haddix	14. TOTAL NUMBER CORE BOXES: 4
6. DIRECTION OF HOLE: [X] VERTICAL [ ] INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER:
	16. DATE HOLE: STARTED 29 Feb 84; COMPLETED 12 Mar 84
7. THICKNESS OF OVERBURDEN: Wasted Rock 8.1	17. ELEVATION TOP OF HOLE: 1041.3
8. DEPTH DRILLED INTO ROCK: Core 26.3	18. TOTAL CORE RECOVERY FOR BORING: 100 %
9. TOTAL DEPTH OF HOLE: 34.4	19. SIGNATURE OF INSPECTOR: Dave Nugen

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
1041.3			Not Sampled			Drilled with Davey Air Drill and Tricone Rock Bit
1033.2						
1032.7			SANDSTONE, mod. hard gr, fine grained, silty			1028.1 Lost Drill water
1031.8				100	1	1027. Founding Elev Mono 14.
1031.1			SILTSTONE, mod. hard, dk. gr. sandy, shaly			
			CLAYSTONE, soft-mod hard, dk. gr., sl., sandy			
			SANDSTONE, fine-med grained, hard, gray, w/thin dk gr. mica lam. stained from 1029.1-1027.1 wd. open, br, sand fil. high angle jt. 1028.6-1028.1	100	1026.5	
					2	1017.0 horz. parting w/frac. & gr. clay coating
				100	1019.3	1016 - 0.2 gouge w/low angle soft gr. CL. filling @ contact 1015.7-1015.4 wd la frac. 1015.3-1014.3 bkn. irreg non-sta. high angle joint.
1017.6			SANDSTONE, mod-hard, hard fine grained, med gray micaceous	100	3	
1016.0			SILTSTONE, mod. hard, dk. gray, w/calcareous incl.			1014.2 Founding EL. Mono 13
1013.9					1012.7	1013.3-1013.1 bkn. sta. open, high angle joint
			SANDSTONE, mod. hard, med. gray, silty, fine grained, clayey below 1008.7 1009.0-1008.7 CLS zo. w/soft plastic clay lens	100	4	1012.9-1012.7 silty zone 1012.7-1011.9 open irregular high angle joint set w/trace clayey coating
1007.4				100	1006.9	
1006.9			CLAYSTONE, soft. med gr.			
			Bottom of Hole			1011.3 clay coated parting 1010.9-1010.4 silty zone 1010.9-1010.7 low angle joint 1007.0-1006.9 very soft. carbanceous

Hole No. 207

DRILLING LOG	DIVISION: Ohio River	INSTALLATION: Pittsburgh District	SHEET OF 2 SHEETS

1. PROJECT: Stonewall Jackson Lake Dam	10. SIZE AND TYPE OF BIT: 4-Inch ID Diamond
2. LOCATION (Coordinates or Station): Mono 12 D/S LF. Corner	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL
3. DRILLING AGENCY: Crown Pressure Grouting	12. MANUFACTURER'S DESIGNATION OF DRILL: Sprague-Henwood 40C
4. HOLE NO. (As shown on drawing title and file number): 207	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED ---- UNDISTURBED ----
5. NAME OF DRILLER: R. Haddix	14. TOTAL NUMBER CORE BOXES: 5
6. DIRECTION OF HOLE: [X] VERTICAL [ ] INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER: ---
	16. DATE HOLE: STARTED 29 Feb 84; COMPLETED
	17. ELEVATION TOP OF HOLE: 1039.2
7. THICKNESS OF OVERBURDEN: Wasted Rock 34.2	18. TOTAL CORE RECOVERY FOR BORING: %
8. DEPTH DRILLED INTO ROCK: Core 33.6	19. SIGNATURE OF INSPECTOR: Dave Nugen
9. TOTAL DEPTH OF HOLE: 67.8	

ELEVATION (a)	DEPTH (b)	LEGEND (c)	CLASSIFICATION OF MATERIALS (Description) (d)	% CORE RECOVERY (e)	BOX OR SAMPLE NO. (f)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) (g)
1039.2			Not Sampled			Drilled With Davey Air Drill and Tri-Cone Bit
1005.0						Start Retaining Core 1.0 Below Coal Seam.
1002.8			CLAYSTONE, mod. hard, med. gray, sandy, silty	100	1	1004.0, low angle parting 1004.0-1003.4 high ang. slickensided, tight frac. loosing drill water through rock into diversion channel @ approx 1019.
1000.0			SILTSTONE, mod. hard to hard, med. gray 1002.8 low angle open pa.			
998.2			SANDSTONE, hard, fine-med, grained, gr., micaceous	100	997.9	999.0 low angle frac.
994.9			SILTSTONE, mod. hard, med. gray, sandy, w/occ. hard calc nodules		2	997.9-996.6 vertical, irreg. bkn. open, non-stained jt. set. poss. mech. induced
994.1			SILTSHALE, mod. hard, dk. gr	100		996.0-995.6 parting along high angle frac.
			0.3 s-mod hard CLS 994.4			
			SANDSTONE, mod. hard-hard, med. grained, gray silty, micaceous		991.2	994.4 3/8" soft gr. clay seam w/shale frags.

DRILLING LOG (Cont Sheet) | ELEVATION TOP OF HOLE: 1039.2 | **Hole No.** 207

PROJECT: Stonewall Jackson Dam | INSTALLATION: Pittsburgh District | SHEET 2 OF 2 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
987.7			SANDSTONE, cont'd	100	3	986.3-986.1 soft, gray, clay filled frac. w/shale
986.4			SILTSHALE, mod. hard, dk. gr. w/closely spaced pa's.			breccia
983.7			CLAYSTONE, soft, dk. gr. sl., bkn w/mn gouge & breccia	100	984.3	985.7-985.2 non-stained, broken 985.3-984.5, soft gr.
979.8			SANDSTONE, mod hard, fine grained, silty, highly fractured, broken, composed of sheared rock frags & clay	60 (1.2)	4	clay fil. grac. w/breccia 984.5-983.7 bery bkn w/CLAYSTONE frags in soft clay matrix Loss 1.2
979.3			SILTSTONE, mod hard, dk. gr. micaceous	100	978.0	982.4 and 981.3, SS
976.7			CLAYSHALE, soft-mod hard dk. gr. grading sandy below 997.8	100		frags in Clay matrix 979.2, clay filled
975.1			SILTSTONE, mod. hard-hard sandy, med - dk. gray, sandy		5	fracture 1/8" thick 979.-978.8 DF-slick
972.8			SILTSHALE, mod. hard, dk. gray			978.8-978.5 bkn, frac. on slick DF
971.4			CLAYSHALE, mod. hard, calcerous nodules, dk. gr.	100	971.4	977.2, .05 LIMESTONE 971.5 low angle slick
			Bottom of Hole			

ENG FORM 1836-A JUN 67 | PROJECT | HOLE NO.

Hole No. 208

DRILLING LOG	DIVISION Ohio River	INSTALLATION Pittsburgh District	SHEET OF SHEETS

1. PROJECT: STONEWALL JACKSON LAKE DAM	10. SIZE AND TYPE OF BIT: 4-inch ID Diamond
2. LOCATION (Coordinates or Station): DS LF Corner, Mono 11 in Diversion Ch.	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL
3. DRILLING AGENCY: Crown Pressure Grouting	12. MANUFACTURER'S DESIGNATION OF DRILL: Sprague & Henwood 40C
4. HOLE NO. (As shown on drawing title and file number): 208	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED --- UNDISTURBED ----
5. NAME OF DRILLER: R. Haddix	14. TOTAL NUMBER CORE BOXES: 5
6. DIRECTION OF HOLE: [X] VERTICAL [ ] INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER: 1011.5 @ completion
	16. DATE HOLE: STARTED 4 Apr 84; COMPLETED 9 Apr 84
7. THICKNESS OF OVERBURDEN: Wasted Rock 4.8	17. ELEVATION TOP OF HOLE: 1007.0
8. DEPTH DRILLED INTO ROCK: Core 31.9	18. TOTAL CORE RECOVERY FOR BORING: 99 %
9. TOTAL DEPTH OF HOLE: 36.7	19. SIGNATURE OF INSPECTOR: Dave Nugen

ELEVATION a (1007.0)	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
1002.2			Not Sampled			
1001.4			SILTSTONE, mod. hard, med. gr., sandy, calc. nod.			
998.7			SANDSTONE, hard, gray, fine grained, silty, cross-bedded	100	1	1002.0-1001.8 vert. tight frac. 1001.4 wd. parting @ contact.
997.0			CLAYSTONE, soft-mod hard, gray, shaly			1001.4-1001.0, 1001.2 -1000.9 hi angle open jts.
991.3			SANDSTONE, hard, gray, fine grained, silty, w/ irregular shale liminations and breaks. 997.0-995.4 closely spaced coated, sli angular parting	96 (0.2)	995.2 2	1001.1 Lost drill water 10% regained and lost 999.3-999.1 ClSh lam. 998.0-997.5 wd/w frac's. 997.8-997.5 ve. bkn. wd, gr. clay w/some frags
989.5			SILTSHALE, mod-hard. dk. gray w/calc nodules	100		997.4-997.0, overcored
988.1			SILTSTONE, mod. hard, shaly, sandy, mica lam's.		988.1	996.8-995.4 high angle to vert. open non-sta. joint
980.6			SANDSTONE, hard, light-med gray, fine grained, silty, x-bded, w/thin mica lam's 984.6-984.2 high ang. open, non-sta jt., clean	100	3 981.6	995.5-995.2 very bkn. 995.2 Cl. coa on low DF 992.5-992.3 SILTSHALE lam., bkn w/soft gr. clay @ 992.4-992.3 989.7-989.6 CLAYSTONE soft, dk. gr. w/wd. pa 987.0 Founding El. Mono. 10 & 11 985.8, 985.1, 984.7 low angle DF's 980.6 tight contact
979.6				100		
977.1			SILTSTONE, mod. hard, dk. gr., sandy, shaly, w/tan calc incl.		4	978.7-978.5 bkn, slick, w/soft gr. DL @ 978.5
974.7			SILTSHALE, mod. hard, dk. gr. w/tan calc. incl.			977.0-976 9 mech. bkn.
972.9			CLAYSTONE, soft-mod hard, silty, dk. gray, w/tan calc incl.	100	974.3	
970.3			SILTSTONE, mod. hard, dk. gr. shaly.	100	5 970.3	
			CLAYSTONE, mod. hard, dk. gr. slk. w/tan calc incl. grades to brown @ bottom			975.8-974.7, sheared, bkn, sli wd. zo of gr. Clay coated and filled frac's 974.7 gr. cl. fil. contact.
			Bottom of Hole			0.4 left in hole

Hole No. 209

DRILLING LOG	DIVISION: Ohio River	INSTALLATION: Pittsburgh District	SHEET 1 OF 2 SHEETS

1. PROJECT: Stonewall Jackson Lake Cam
2. LOCATION (Coordinates or Station): D/S LF. Corner Mono 10
3. DRILLING AGENCY: Crown Pressure Grouting Co.
4. HOLE NO (As shown on drawing title and file number): 209
5. NAME OF DRILLER: R. Haddix
6. DIRECTION OF HOLE: [X] VERTICAL [ ] INCLINED ______ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN: Wasted Rock 36.9
8. DEPTH DRILLED INTO ROCK: Core 30.3
9. TOTAL DEPTH OF HOLE: 67.2
10. SIZE AND TYPE OF BIT: 4-inch ID Diamond
11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL
12. MANUFACTURER'S DESIGNATION OF DRILL: Sprague & Henwood 40C
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED ---- UNDISTURBED ----
14. TOTAL NUMBER CORE BOXES: 5
15. ELEVATION GROUND WATER: 1012.7
16. DATE HOLE: STARTED 2 Feb 84 COMPLETED 6 Mar 84
17. ELEVATION TOP OF HOLE: 1037.3
18. TOTAL CORE RECOVERY FOR BORING: 99 %
19. SIGNATURE OF INSPECTOR: Dave Nugen

ELEVATION a 1037.3	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			Rock Not Sampled			Start Coring Approx. 1' Below Coal Seam.
						Start saving core approx. 1' below coal seam.
1004.4						
998.8			SANDSTONE, mod. hard, sl.			fine grained, gray
999.1			CLAYSTONE, soft-mod. hard sl., mostly frags in matrix	100%	Box 1	999.8-999.1 has the appearance of shear gouge, very broken
997.9			SANDSTONE, mod. hard, med gr., fine grained, silty			
997.4			SILTSHALE, soft-mod hard, gray			997.4-997.35 claystone seam, wd., clayey, possible low angle shear
			SANDSTONE, mod hard-hard fine grained, silty, gr., interbd. w/SLSH & sandstone lam.		993.9	
992.2				100%		990.1-989.8 appearance of gouge
991.5			SILTSTONE, mod hard, med gr			0.3 soft fractured CLAYSTONE @ 990.1
990.2			SILTSHALE, mod hard, gr. calc. incl.		Box 2	0.5 mod. hard SILTSTONE @989.8
989.8			LIMESTONE, mod hard gr.			
			SANDSTONE, mod. hard-hard			

DRILLING LOG (Cont Sheet) | ELEVATION TOP OF HOLE: 1037.3 | **Hole No.** 209

PROJECT: Stonewall Jackson Dam | INSTALLATION: Pittsburgh District | SHEET 2 OF 2 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO f	REMARKS (Drilling time, water loss, depth of weathering, etc. if significant) g
983.9			SANDSTONE, silty fine grained med. gr. w/thin silty laminations starting 3988.0	100% 100%	Box 3	987.0 Founding El. Mono 10 983.8-982.4-vert. high angle, open irr. non-stained, joint 985.3 grading very silty.
982.4			SILTSTONE, mod. hard, sandy med. gr., w/hard tan nodules @ base		980.4	982.4-slightly wd parting
971.4			CLAYSTONE, mod. hard, dark to med gray, occ. slickensided w/tan calc. inclusions, occ. sandy zo's. 980.7 low angle slick parting 980.4 low angle parting 980.4-979.7 sandy zone 977.3-976.6 sandy zone	100% 100%	Box 4 973.5 Box 5	979.3-978.9 very bkn w/slickensides and series of low angle pa's to 978.5 975.6 core spin 975.0-974.4 sandy zones 973.9 broken wd. parting 972.8-972.0 sandy zone 971.8 low angle frac's & occ. hard nod. to 971.4
970.1			INDURATED CLAY, mod. hard, red-reddish br., slickensided.	(0.1)	970.1	Bottom of Hole last run was over-drilled-The core was left in the hole after the first run.

ENG FORM 1836-A JUN 67 | PROJECT | HOLE NO

Hole No. 210

DRILLING LOG	DIVISION: Ohio River	INSTALLATION: Pittsburgh District	SHEET 1 OF 1 SHEETS

1. PROJECT: Stonewall Jackson Dam	10. SIZE AND TYPE OF BIT: NX Diamond
2. LOCATION (Coordinates or Station): Mono 9 DS Right Corner	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL
3. DRILLING AGENCY: Crown Pressure Grouting	12. MANUFACTURER'S DESIGNATION OF DRILL: Sprague & Henwood 40 C
4. HOLE NO. (As shown on drawing title and file number): 210	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED – UNDISTURBED –
5. NAME OF DRILLER: R. Haddix	14. TOTAL NUMBER CORE BOXES: 5
6. DIRECTION OF HOLE: [X] VERTICAL [ ] INCLINED ___ DEG. FROM VERT.	15. ELEVATION GROUND WATER: Artesian
	16. DATE HOLE: STARTED 23 Feb 84 COMPLETED 24 Feb 84
7. THICKNESS OF OVERBURDEN: 0	17. ELEVATION TOP OF HOLE: 1000.5
8. DEPTH DRILLED INTO ROCK: 31.0	18. TOTAL CORE RECOVERY FOR BORING: %
9. TOTAL DEPTH OF HOLE: 31.0	19. SIGNATURE OF INSPECTOR: Dave Nugen

ELEVATION 1000.5 (a)	DEPTH (b)	LEGEND (c)	CLASSIFICATION OF MATERIALS (Description) (d)	% CORE RECOVERY (e)	BOX OR SAMPLE NO. (f)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) (g)
999.1			CLAYSTONE, very soft, wd. grad to CLS w/siltstone incl	66		999.7-999.4 Open vert. fracture
997.6			SANDSTONE, silty, mod. hard med. gray	80	Box 1	999.1 bkn at contact
995.8			SILTSTONE, sandy, mod. hard, med. gray, shaly	94		Artesian flow after 1st run
992.0			SANDSTONE, silty, fine grained, mod. hard to hard, gray, interbd. w/siltstone lam., occ. calc. nod. silty partings	100	993.8	998. horz. siltshale parting
991.0			SILTSTONE, sandy, shaly mod. hard, dk. gray			997.6 core spin at contact
988.8			CLAYSTONE, mod. hard, dk. gray, occ. sandy, shaly slk. pyritic		Box 2	997.4-997.1 mech. core loss.
983.6			SANDSTONE, silty, fine grained, hard, med. gray	100	986.7	989.2-988.8 bkn soft, clayey, slk. 987.3-986.8 mod. hard gray siltstone.
982.3			SILTSHALE, mod hard, gr.	100	Box 3	
980.2			SANDSTONE, silty, fine grained, hard, gr, micaceous		980.0	985.6-985.5 mech. broken
977.0			CLAYSHALE, mod. hard, sandy gr., occ. slick, w/occ large tan calc. incl.	100		Found Elev. Mono 9-985.0
973.3			SILTSTONE, shaly, mod. hard, dk. gr. w/tan calc. incl. occ. sandy		Box 4	983.6 low angle contact w/trace gray clayey coating.
971.2			SILTSHALE, mod. hard, dk. gr. occ. sli sandy	100	972.8 Box 5	982.3 low angle cont. w/trace gray clayey coating
969.5			CLAYSTONE, shaly, mod. hard, gr. to brown	100	969.5	
			BOTTOM OF HOLE			977.5 irregular slick parting 977.0-974.4 very sandy 973.2, low angle soft to mod. hard clayshale parting. 970.8-970.5 mech. bkn w/angular pieces.

ENG FORM 1836 | PROJECT | HOLE NO.

Hole No. 211

DRILLING LOG	DIVISION: Ohio River	INSTALLATION: Pittsburgh District	SHEET 1 OF 1 SHEETS

1. PROJECT: Stonewall Jackson Dam	10. SIZE AND TYPE OF BIT: 4-inch ID Diamond
2. LOCATION (Coordinates or Station): MONO 7 DS Right Corner	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL
3. DRILLING AGENCY: Crown Pressure Grouting	12. MANUFACTURER'S DESIGNATION OF DRILL: Sprague & Henwood 40 C
4. HOLE NO. (As shown on drawing title and file number): 211	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED - ; UNDISTURBED -
5. NAME OF DRILLER: R. Haddix	14. TOTAL NUMBER CORE BOXES: 5
6. DIRECTION OF HOLE: [X] VERTICAL [ ] INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER: 1001.7
	16. DATE HOLE: STARTED 20 Feb 84; COMPLETED 21 Feb 84
7. THICKNESS OF OVERBURDEN: 0	17. ELEVATION TOP OF HOLE: 1003.9
8. DEPTH DRILLED INTO ROCK: 32.0	18. TOTAL CORE RECOVERY FOR BORING: %
9. TOTAL DEPTH OF HOLE: 32.0	19. SIGNATURE OF INSPECTOR: Dabe Nugen

ELEVATION a (1003.9)	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
1001.5			COAL, REDSTONE, black blocky, pyritic	64		1003.9-1001.5 very bkn. w/0.9 accum. loss.
999.0			CLAYSTONE, silty, mod hard, mod. gray	90	Box 1	
996.8			SANDSTONE, silty, fine grained, mod. hard, to hard, med. gray	100	997.2	1001.7-24 hour water level
995.1			SILTSTONE, sandy, soft gray	100		1001.5-1000.7 carb. & pyritic
994.1			SANDSTONE, silty, mod. hard, gray, fine grain		Box 2	1001.1 core spin
991.9			SILTSTONE, sandy, shaly, mod hard, gray ss lenses			1001.1-996.6 grades to mod hard siltstone
989.3			SILTSHALE, mod hard, dk gr. occ CL SH	100	990.0	999.4 soft gr. clay coated parting brown calc. incl.
988.8			CLAYSTONE, s-mod hard			999.2-999.0 clay lens. mech bkn (?)
987.0			SANDSTONE, silty mod. hard	100	Box 3	998.7-998.6 CLAYSTONE 998.6 mech bkn. calc. incl.
986.5			SILTSHALE, mod hard to hard gray			
985.4			SILTSTONE, mod. hard- hard		983.1	997.2 thin siltshale partings
984.5			SANDSTONE, m. hard to hard	100		
977.0			SILTSHALE, mod. hard, dk. gray, occ. sandy slickensided, w/scat. calc. nod.	100	Box 4	996.5-996.2 claystone soft w/irreg CL coa partings 979.1-970.0 slick at top of run.
975.8			SILTSTONE, mod. hard, gr. slick on irr parting, incl's		976.2	
974.6			SILTSHALE, mod. hard, gr. slick on fractures			974.6 mech bkn. slickensided
973.2			CLAYSTONE, silty, gray mod. hard, calc. incl.	100	Box 5	
972.3			SANDSTONE, mod. hard, very fine grained, gray			
971.9			CLAYSTONE, mod. hard, dark gr., slickensided			
			BOTTOM OF HOLE 0.2 LEFT IN HOLE			

Hole No. 212

DRILLING LOG	DIVISION: Ohio River	INSTALLATION: Pittsburgh District	SHEET 1 OF 1 SHEETS

1. PROJECT: Stonewall Jackson Dam	10. SIZE AND TYPE OF BIT: 4 inch Diamond
2. LOCATION (Coordinates or Station): MONO 6-DS Right Corner	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL
3. DRILLING AGENCY: Crown Pressure Grouting Co.	12. MANUFACTURER'S DESIGNATION OF DRILL: Sprague and Henwood 40 C
4. HOLE NO (As shown on drawing title and file number): 212	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED – UNDISTURBED –
5. NAME OF DRILLER: R. Haddix	14. TOTAL NUMBER CORE BOXES: 4
6. DIRECTION OF HOLE: [x] VERTICAL [ ] INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER: 1002.6
	16. DATE HOLE: STARTED 21 Feb 84 COMPLETED 22 Feb 84
7. THICKNESS OF OVERBURDEN: 0	17. ELEVATION TOP OF HOLE: 1004.4
8. DEPTH DRILLED INTO ROCK: 25.5	18. TOTAL CORE RECOVERY FOR BORING: %
9. TOTAL DEPTH OF HOLE: 25.5	19. SIGNATURE OF INSPECTOR: Dave Nugen

ELEVATION 1004.4 (a)	DEPTH (b)	LEGEND (c)	CLASSIFICATION OF MATERIALS (Description) (d)	% CORE RECOVERY (e)	BOX OR SAMPLE NO. (f)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) (g)
1003.6			SILTSTONE, clayey, soft, med. gray, carb str's.	66		1004.4-1000.3 very bkn w/1.2 accum. loss
1000.3			COAL, REDSTONE bk, blocky pyritic	75	Box 1	1000.3-999.9, hard bony coal
998.6			CLAYSTONE, shaly, soft-mod. hard, gray, carb.	88		998.9-998.7, bkn wd., iron sta. w/o.l loss.
996.0			SANDSTONE, silty, mod hard fine grained, med gray	98	997.7	996.8-996.6 high angle, irreg. open jt.
995.7			SILTSTONE, clayey, shaly soft-mod hard, gray			988.8-988.4 bkn. w/slickensides
994.8			SANDSTONE, silty, fine grained, mod hard, gray		Box 2	
991.6			SILTSTONE, shaly, dark gray, mod hard, sandy lam., carb.	100		988.0 irreg. slick contact
988.9			SILTSHALE, sandy, mod. hard, dk gr., calc. incl. pyrite		990.0	987.4 found Elev. MONO 6
988.0			CLAYSTONE, dk. gr., soft-mod hard, slk.		Box 3	Pyrite @ 987.4
986.2		18.2	SANDSTONE, silty, fine grain, mic, mod. hard	100		986.4-986.2 thin vert. healed fract.
984.6		19.8	SILTSHALE, mod hard, gr., sa. lams		983.6	
982.1			SANDSTONE, silty, hard, fine grained, gray, mic.		Box 4	
981.0			SILTSTONE, sandy, mod. hard, gray, calc. incl.	100		
980.6			CLAYSHALE, mod hard, sl.			
979.5			SILTSTONE, hard, sa, mic.	100	978.9	
978.9			SILTSTONE, mod. hard, shaly, carb. zo's.			
			BOTTOM HOLE			

Hole No. 213

DRILLING LOG	DIVISION: OHIO RIVER	INSTALLATION: Pittsburgh District	SHEET 1 OF 1 SHEETS

1. PROJECT: Stonewall Jackson Dam	10. SIZE AND TYPE OF BIT: 4-inch Diamond
2. LOCATION (Coordinates or Station): Mono 5 DS end	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL
3. DRILLING AGENCY: Crown Pressure Grouting	12. MANUFACTURER'S DESIGNATION OF DRILL: Sprague & Henwood 402
4. HOLE NO. (As shown on drawing title and file number): 213	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED – UNDISTURBED –
5. NAME OF DRILLER: R. Haddix	14. TOTAL NUMBER CORE BOXES: 5
6. DIRECTION OF HOLE: [X] VERTICAL [ ] INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER: 1008.1
	16. DATE HOLE: STARTED / COMPLETED
7. THICKNESS OF OVERBURDEN: Wasted lock 0.9	17. ELEVATION TOP OF HOLE: 1013.9
8. DEPTH DRILLED INTO ROCK: Core 34.2	18. TOTAL CORE RECOVERY FOR BORING: %
9. TOTAL DEPTH OF HOLE: 35.1	19. SIGNATURE OF INSPECTOR: Dave Nugen

ELEVATION 1013.9 (a)	DEPTH (b)	LEGEND (c)	CLASSIFICATION OF MATERIALS (Description) (d)	% CORE RECOVERY (e)	BOX OR SAMPLE NO. (f)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) (g)
1013.0			CLAYSTONE - REAMED			
			CLAYSTONE, mod. hard, w/scattered lt. br calc. incl., very bkn. to 1008.1	66	Box 1	1008.1-24 hour water level
				81		1007.8-1007.1 several small healed fractures
1006.4					1006.4	
1004.4			SANDSTONE, silty, fine grained, mod. hard, gray	71		1006.5 soft gray clay filled, non-stained weathered partings
1002.6			CLAYSHALE, gray, sandy mod. hard		Box 2	1005.5 irreg. parting @ slick lam.
999.3			COAL, REDSTONE, black, pyritic, blocky	100	999.3	1004.6, 1-inch weathered gr. clay (mech silty parting)
997.5			CLAYSTONE, silty, mod hard, gr., cal. incl.			1004.4, low angled healed fract.
			SILTSTONE/SANDSTONE interbedded, mod hard, gray, SS fine grained.	100	Box 3	1003.4-1003.1 becoming carbonaceous 1003.' carb. SLS mod. hard, gray and black.
					992.6	
988.6				100	Box 4	999.6-999.3 bkn. along ha vert frac. 999.3-998.9 carb. zo.
987.4			CLAYSTONE, silty, mod hard, gr.			998.5 and 998.1 h.angle slick parting (mech)
985.3			SANDSTONE, silty, hard, fine grained, gray.	100	985.9	
980.5			SILTSTONE, sandy, mod hard, shaly, med gr.		Box 5	997.9-997.5, sli wd. non-stained. 997.5 trace gr. clay coating 997.2-996.4 very sh. 995.8-995.2 SLS, hard w/bk. cherty carb. incl
979.3			SANDSTONE, hard, sl., gr.	100	978.8	995.2-994.2 very sandy
978.8			SILTSTONE, sa. mod hard, gr BOTTOM OF HOLE			993.3-993.0 CLS mod. hard, random. fract., gray. 992.1-991.9 very san. 988.2 low ang. slick pa 987.9-987.7 bkn along high ang. frac. w/1" gr. cl fill irr parting w/CLS frags @ 987.7 987.7-987.4 fine cracks 987.4 found El Mon 5

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE TRANSLUCENT | PROJECT: STONEWALL JACKSON | HOLE NO. 213

Hole No. [illegible]

DRILLING LOG

Field	Entry
DIVISION	Ohio River
INSTALLATION	Pittsburgh [illegible]
SHEET	OF [illegible] SHEETS
1. PROJECT	Stonewall Jackson Dam
2. LOCATION (Coordinates or Station)	Mono 4/5 Joint, Center of M.4
3. DRILLING AGENCY	Crown Pressure Crouting
4. HOLE NO. (As shown on drawing title and file number)	C 214
5. NAME OF DRILLER	R. Haddix
6. DIRECTION OF HOLE	[X] VERTICAL [ ] INCLINED ____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN	0
8. DEPTH DRILLED INTO ROCK	33.6
9. TOTAL DEPTH OF HOLE	33.6
10. SIZE AND TYPE OF BIT	[illegible] Diamond
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	MSL
12. MANUFACTURER'S DESIGNATION OF DRILL	Sprague & Henwood 40C
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN	DISTURBED – ; UNDISTURBED –
14. TOTAL NUMBER CORE BOXES	5
15. ELEVATION GROUND WATER	1006.4
16. DATE HOLE	STARTED 14 Fev. 84 ; COMPLETED 15 Feb. 84
17. ELEVATION TOP OF HOLE	1011.7
18. TOTAL CORE RECOVERY FOR BORING	97 %
19. SIGNATURE OF INSPECTOR	Dave Nugen

ELEVATION (a) 1011.7	DEPTH (b)	LEGEND (c)	CLASSIFICATION OF MATERIALS (Description) (d)
1007.2			CLAYSTONE, soft, silty med. gray, shaly w/ occ. slickensides
1004.2			SILTSHALE, mod. hard, gr., sandy, w/occ. sandstone bands and calc. incl.
1003.8			CLAYSHALE, soft-mod. h. gr.
'000.3			SILTSTONE, mod. hard, sandy occ. carb & slk, ha DF's
1000.0			SILTSTONE, mod. hard, carb, pyritic
999.0			SILTSTONE, soft to mod. hard, gr, w/siltshale zo's
993.1			SANDSTONE, silty, hard, fine grained, med. gr.
991.1			SILTSTONE, sandy, mod hard, gr. w/scat hard incl.
988.8			CLAYSTONE, silty, soft to mod. hard, sh, pyritic
988.3			IND. CLAY, soft, slk, gr. w/ wd
987.7			LIMESTONE, hard, gr. pyritic, w/irr. ha joint
984.9			SANDSTONE, silty, fine grain, hard, med gr.
983.8			SILTSTONE, shaly, mod hard, med gr., w/occ calc nod.
981.8			SANDSTONE, silty, mod. hard, -hard, gray
980.7			CLAYSTONE, shaly, mod hard, gray, w/brown incl.
979.0			SANDSTONE, fine grain, hard, silty
978.1			SILTSTONE, mod. hard, dk. gr. w/hard br. incl.
			BOTTOM OF HOLE

% CORE RECOVERY (e): 85, 80, 100, 100, 100, 100, 100, 96, 100, 100

BOX OR SAMPLE NO. (f): Box 1, Box 2, Box 3, Box 4, Box 5

REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) (g):

1011.7-101104 Loss
1011.4-1010.5 bkn w/ high angle joint.
1011.1-1009.7 Cong. Zone
1009.7-1007.7 very bkn., overdrilled
1009.4-1008.5, mod. hard, gr., CLAYSHALE
1008.5, la. slickenside
1006.4, 24 hr. water level
1005.6-1004.9 SS zone
1004.1-1003.8, weather-ed, fractured
1003.8-1003.8, mech bkn.
1000.9-1000.5, carb, slickensided
1000.6-1000.3, mech. bkn w/ coal frags.
999.6, weath., num. stained partings
999.2, clay coated pa.
996.7 Found Elev. Mono 4
994.3-993.4 Bk. sil incl
994.1-993.9, siltstone zones
993.9-993.6, CLSHALE zone.
988.3, slickensided part
987.7 Found Elev. Mono 5
984.9 1/8" tk. mod. hard Clayshale
No loss of Drill Water

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE

TRANSLUCENT

PROJECT STONEWALL JACKSON | HOLE NO. C-214

Hole No.

DRILLING LOG

DIVISION	OHIO RIVER
INSTALLATION	PITTSBURGH DISTRICT
SHEET	OF 2 SHEETS
1. PROJECT	Stonewall Jackson Dam
2. LOCATION (Coordinates or Station)	Mono 3 D/S Rt. Corner
3. DRILLING AGENCY	Crown Pressure Grouting
4. HOLE NO. (As shown on drawing title and file number)	215
5. NAME OF DRILLER	R. Haddix
6. DIRECTION OF HOLE	[X] VERTICAL [ ] INCLINED ____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN	43.9
8. DEPTH DRILLED INTO ROCK	25.6
9. TOTAL DEPTH OF HOLE	69.5
10. SIZE AND TYPE OF BIT	4-inch Diamond
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	MSL
12. MANUFACTURER'S DESIGNATION OF DRILL	Sprague & Henwood 402
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN	DISTURBED: – UNDISTURBED: –
14. TOTAL NUMBER CORE BOXES	4
15. ELEVATION GROUND WATER	1030.0 (24 hrs)
16. DATE HOLE	STARTED: 31 Jan 84 COMPLETED: 3 Feb 84
17. ELEVATION TOP OF HOLE	1055.9
18. TOTAL CORE RECOVERY FOR BORING	%
19. SIGNATURE OF INSPECTOR	Dave Nugen

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
1055.9			Rock-Not Sampled From 1055.9 - 1012.0			Davey Air Drill w/ 6 ¾ DIA Tricone Rock Bit to 1026.9
						1030.0 - 24 Hour Water
						1026.9 MATL SLI DAMP
						CORE BARREL w/DIA Bit used 1026.9 to 1012.0, CORE WASTED, no Drill Water Return
1012.0						
1010.9			SILTSTONE, soft, clayey, gr. w/scat. calc. incl.			1011.3 to 1010.9 mech. bkn.
1007.5			CLAYSTONE, soft, gr, w/scat br. & gr. calc. incl.	100	BOX 1	OCC. low angle gr. clayey coa. slk. pas. to 1009.1
1006.0			SILTSTONE, soft-mod. hd, gr. sandy, shaly			1008.4 - 1008.1 mech loss

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE (TRANSLUCENT)

PROJECT: STONEWALL JACKSON HOLE NO. 215

DRILLING LOG (Cont Sheet) | ELEVATION TOP OF HOLE: 1055.9 | **Hole No.** 215

PROJECT: Stonewall Jackson Dam | INSTALLATION: Pittsburgh District | SHEET 2 OF 2 SHEETS

ELEVATION (a)	DEPTH (b)	LEGEND (c)	CLASSIFICATION OF MATERIALS (Description) (d)	% CORE RECOVERY (e)	BOX OR SAMPLE NO (f)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) (g)
1004.7			CLAYSHALE, sandy, med. gr, mod. hard	100		1008.1-1007.8 mech bkn.
1002.7			SILTSTONE, fine grain, mod hard, gr, w/fine grain SS bands	100	Box 2	1003.5-1003.3 mech bkn.
1002.1			SILTSTONE, sandy, gr., mod hard, shaly			1002.1 smooth horz parting w/trace pyrite & lt. gr. coating
1001.6			CLAYSTONE, soft, gr., shaly	100		1001.9 horz gr. cl coated parting
997.3			COAL, REDSTONE, blocky, bkn			995.8, low angle gray clay coated, slicken-sided parting
996.7			CARB. SHALE, soft, dk. gr.			
995.6			INDURATED CLAY, soft to med. hard, gr.	100	Box 3	Foundation Elev. MONO 3 - 995.6
992.5			SANDSTONE, mod. hard, gr, sl			fine grained SS 992.5
			SILTSHALE, mod. hard, med gr.	100	Box 4	991.2-989.9 silty sandstone 989.3-989.2, Clayshale mod. hard, med. gr.
986.4			SILTSTONE, mod hard, med. gr.	100		
			BOTTOM OF HOLE			NOTE: Drill water coming out of Hillside along Bedding Parting Approx. 180 feet N 11°E of Hole, at Elev. 1025.6

ENG FORM 1836-A JUN 67 | GPO 1967 OF—267-679 | PROJECT: STONEWALL JACKSON | HOLE NO: 215

Hole No. 216

DRILLING LOG	DIVISION: Ohio River	INSTALLATION: Pittsburgh District	SHEET OF 2 SHEETS

1. PROJECT: Stonewall Jackson Dam	10. SIZE AND TYPE OF BIT: 4" ID Diamond
2. LOCATION (Coordinates or Station): Monolith 2, Rt. Corner D/S End	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL
3. DRILLING AGENCY: Crown Pressure Grouting Co.	12. MANUFACTURER'S DESIGNATION OF DRILL: Sprague & Henwood 40C
4. HOLE NO. (As shown on drawing title and file number): 216 (DWG 18/21)	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED ---- UNDISTURBED ----
5. NAME OF DRILLER: R. Haddix	14. TOTAL NUMBER CORE BOXES: 4
6. DIRECTION OF HOLE: [X] VERTICAL [ ] INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER: 1038.1
	16. DATE HOLE: STARTED 24 Jan 84; COMPLETED 31 Jan 84
7. THICKNESS OF OVERBURDEN: Waster Rock 41.6	17. ELEVATION TOP OF HOLE: 1081.6
8. DEPTH DRILLED INTO ROCK: Core 22.0	18. TOTAL CORE RECOVERY FOR BORING: 100 %
9. TOTAL DEPTH OF HOLE: 63.6	19. SIGNATURE OF INSPECTOR: Dave Nugen

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
1081.6			ROCK NOT SAMPLED between 1081.6-1040.0			Used 4" I.D. Sawtooth Barrel to 1075.6 4" x 5 1/2" Double tube core barrel used from 1075.6 to the bottom of hole core retained only below 1040.
1040.0						
1039.3			CLAYSTONE, soft, med. gr. silty, sandy, w/scat cal nod	100	Box 1	1040.-1039.8 slickensided parting 1038.1, 24 Hr. Water Level
			SANDSTONE, mod. hard, fine grained, gray, w/occ. small calc. inclusions 1037.9	100		1037,9-1037.8 stained irregular, open wd, pa. 1037.8-1037.2 silty & clayey lam. w/cal. incl.
1033.2					1033.2	
			SILTSTONE			

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE (TRANSLUCENT)

PROJECT: Stonewall Jackson Dam — HOLE NO. 216

DRILLING LOG (Cont Sheet) ELEVATION TOP OF HOLE 1081.6 **Hole No.** 216

PROJECT Stonewall Jackson Dam | INSTALLATION Pittsburgh District | SHEET 2 OF 2 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
1028.4			SILTSTONE, mod. hard, med. gray, clayey, occ. sandy w/sm. clac. inclusions	100	Box 2	1036.8-1036.0 broken open, high angle, wide stained joint.
1028.1			CLAYSTONE, soft-mod. hard, gr. silty, slickensides	100	1026.4	1028.6-1028.1 mech. bkn. w/core spin
1024.1			SILTSTONE, clayey, mod. hard, med. gray, w/occ. calc. inclusions	100	Box 3	1028.1-1027.1 bkn. along irreg. high angle fracture
1021.8			CLAYSTONE, soft-mod. hard, med. gray			1027.1-1026.5 low angle slickensided pa's also 1026.6-1026.4
1019.6			SILTSTONE, mod. hard, med. gr., silghtly sandy, occ. calc. inclusions	100	1019.6	1026 FOUNDING ELEV. Mono 2
1018.5			CLAYSTONE, mod. hard, med. gray			1019.6-1019.3 mech. bkn.
1015.3			SILTSTONE, mod. hard, med. gray, shaly	100	Box 4	1018.5-1018.2 fine grained sandstone lam.
						BOTTOM OF HOLE No lose of drill water

Hole No. 217

DRILLING LOG	DIVISION: Ohio River	INSTALLATION: Pittsburgh District	SHEET 1 OF 2 SHEETS

1. PROJECT: Stonewall Jackson Dam	10. SIZE AND TYPE OF BIT: 4" ID Diamond
2. LOCATION (Coordinates or Station): Monolith 1 D/S Right Corner	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL
3. DRILLING AGENCY: Crown Pressure Grouting	12. MANUFACTURER'S DESIGNATION OF DRILL: Sprague & Henwood 40C
4. HOLE NO. (As shown on drawing title and file number): 217 (DWG 18/21)	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED ---- UNDISTURBED ----
5. NAME OF DRILLER: R. Haddix	14. TOTAL NUMBER CORE BOXES: 4
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER: 1070.1
	16. DATE HOLE: STARTED 3 Feb 84 COMPLETED 9 Feb 84
7. THICKNESS OF OVERBURDEN: Wasted Rock 34.4	17. ELEVATION TOP OF HOLE: 1094.4
8. DEPTH DRILLED INTO ROCK: (core) 27.0	18. TOTAL CORE RECOVERY FOR BORING: 100 %
9. TOTAL DEPTH OF HOLE: 61.4	19. SIGNATURE OF INSPECTOR: Dave Nugen

ELEVATION 1094.4 a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
1060.0			ROCK NOT SAMPLED BETWEEN 1094.4-1060.0			1094.4-1066.4 drilled with 6 1/4" O.D. Tricone Rock Bit on Davey Air Drill 1070.1-24 HR Water Level 1066.4 to bottom of hold used 4" x 5 1/4" core barrel with diamond bit retained core below 1060.0
1055.5			CLAYSTONE/INDURATED CLAY red & gray, w/several high & low angle irregular slick-ensided, pa's., bkn into 2' - 5' lengths	100%	Box 1	1057.3-1056.8 soft bkn (mech)
1053.1			SILTSTONE, soft-mod hard, gray, sandy w/gr. calc. inclusions		1053.4	1056.0 mech. break
1048.8			SANDSTONE, mod. hard, fine grained, gray, shaly, w/ small calc. inclusions to 1052.2	100%	Box 2	1054.2-1053.4 very sandy 1053.1 open, bkn, mech, contact
1045.4			CLAYSTONE/INDURATED CLAY soft, red-gray, w/occ. calc. inclusions, slicken-sided	100%	1046.3	grading very silty starting @ 1050.4
			SANDSTONE			

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PROJECT: Stonewall Jackson Dam HOLE NO. 217

DRILLING LOG (Cont Sheet)	ELEVATION TOP OF HOLE 1094.4	Hole No. 217
PROJECT Stonewall Jackson Dam	INSTALLATION Pittsburgh District	SHEET 2 OF 2 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
1041.9			SANDSTONE, mod. hard, fine grain, silty, scat. calc. incl., more silty w/depth	100%	Box 3	1045.4 open non-stained, slickensided contact 1045.1 foundation Mono. 1
1039.2			CLAYSTONE, mod. hard, med. gray, w/calc. inclusions	100%	1039.4	
1033.0			SANDSTONE, mod. hard, med. gray, fine grained, w/scat. small calc. inclusions, sand content increasing w/depth.	100%	Box 4 1033.0	
						BOTTOM OF HOLE No Loss of Drill Water

ENG FORM 1836-A JUN 67

PROJECT	HOLE NO
STONEWALL JACKSON DAM	217

Hole No.

DRILLING LOG	DIVISION: Ohio River	INSTALLATION: Pittsburgh District	SHEET OF [illegible] SHEETS

1. PROJECT: Stonewall Jackson Lake Dam	10. SIZE AND TYPE OF BIT: [illegible]-inch [illegible] Diamond
2. LOCATION (Coordinates or Station): Mono 12-13 Joint-85' DS E	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL
3. DRILLING AGENCY: Crown Pressure Grouting Co.	12. MANUFACTURER'S DESIGNATION OF DRILL: Sprague & Henwood 40C
4. HOLE NO. (As shown on drawing title and file number): 218	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED ------ UNDISTURBED ------
5. NAME OF DRILLER: R. Haddix	14. TOTAL NUMBER CORE BOXES: 10
6. DIRECTION OF HOLE: [X] VERTICAL [ ] INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER: 1017.5
	16. DATE HOLE: STARTED 26 March 84; COMPLETED 29 March 84
7. THICKNESS OF OVERBURDEN: 0	17. ELEVATION TOP OF HOLE: 1039.5
8. DEPTH DRILLED INTO ROCK: 69.0	18. TOTAL CORE RECOVERY FOR BORING: 97 %
9. TOTAL DEPTH OF HOLE: 69.0	19. SIGNATURE OF INSPECTOR: Dave Nugen

ELEVATION (a)	DEPTH (b)	LEGEND (c)	CLASSIFICATION OF MATERIALS (Description) (d)
1039.5			
1035.0			SANDSTONE, mod. hard, gray, fine grained, silty, brown staining, micaceous, weathered.
1033.5			SILTSTONE, soft-mod. hard, gr., core loss, overcored
1033.1			CLAYSHALE, soft, gr., very wd., calc. incl, sa. str's
1019.2			SANDSTONE, mod. soft to mod. hard, gr. w/brown staining, fine to med. grained, cross bedded med grained below 1027.7 1032.3-1029.2, stained w/open wd. partings and joints. 1028.7-1027.9 stained 1028.5-1028.3 open wd. high angle joint 1027.2 stained parting 3 thin mica lam.
1014.3			SANDSTONE, mod. hard, med. gr., fine grained, sl., limy
1012.5			SILTSTONE, mod. hard, gray, occ. snady, w/calc. incl.
1011.4			IND. CLAY-SILTSTONE, mod hard, gray, brecciated
1011.1			CLAYSTONE, mod soft, calc., fractures
1009.3			SANDSTONE, silty, fine grained, x-bded, w/calcite fil. frac's
1008.2			CLAYSTONE, soft to mod. hard, slk., dk gr. shaly
1007.3			SHALE, mod. hard, black, carb. sandy
1006.8			SANDSTONE, mod. hard, fine grain, sl. bk, carb str's.
1006.1			COAL, REDSTONE, blocky
1001.7			CLAYSTONE, soft-mod hard dk. gr., slk, shaly
997.5			SILTSTONE, mod. hard, dk gr., sandy, interbd. w/ fine grained gr. Sandstone
993.6			SILTSTONE, mod. hard shaly, dark gray, w/ scattered calc. incl.
993.1			CLAYSTONE, soft-mod hard, dk. gr. gough 995.6-993.5
			SANDSTONE, mod. hard, med. gr., fine grained, silty, limy clayey lam's.

% CORE RECOVERY (e)	BOX OR SAMPLE NO. (f)
84 (0.3)	Box 1
65 (0.7)	
30 (1.4)	1032.8
100	Box 2
100	1025.6
100	Box 3
100	1018.3
100	Box 4
100	1011.6
100	Box 5
100	1004.3
100	Box 6
100	998.6
100	Box 7
100	991.3

REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) (g)

WATER LEVEL VARIES w/ RIVER LEVEL
1039.5-1037.6 broken w/br. staining along high angle jt. 0.3 loss
1037.6-1035.6 high angle fractures, bkn, w/0.7 loss
1033.5-1033.1 possible gouge
1033.1-1032.9 bkn, stained
1033.1-1032.7 high angle, open sta. joint
1025.4-1024.7 stained
1025.2-1025.0 wd. parting and joint
1023.5 stained wd. parting
1022.8-1020.9 stained very wd., soft-mod. hard
1022.8-1022.2 stained partings
1022.0-1021.7 wd. open high angle joint
1021.3-1021.[illegible] wd. partings
1020.5-1020.2, sta. wd. partings
1019.3-1019.2 conglomerate lens
1018.6-1018.3 parted along fracture
1018.0-1017.9 healed IDF
1017.5-1017.0 stained high angle DF w/ associated breaks
1016.9-1015.8 SILTSTONE mod. hard, calc. fillings
1015.8 low angle open stained joint w/frag's.
1015.5-1014.3 stained, open, vert to hi angle joint
1013.9-1013.4 healed fractures.
1012.4-1012.1 fractures
1011.8-1011.6 soft, slk, bkn.
1011.6-1011.4 CLAY GOUGE w/SILTSTONE frags, very soft.
1010.1 parting 3 shaly clay str.

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE (TRANSLUCENT)

PROJECT: STONEWALL JACKSON DAM HOLE NO. 218

DRILLING LOG (Cont Sheet)	ELEVATION TOP OF HOLE 1039.5				Hole No. 218	
PROJECT STONEWALL JACKSON DAM			INSTALLATION PITTSBURGH DISTRICT			SHEET 2 OF 2 SHEETS
ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
981.9			SANDSTONE, cont'd. micaceous, mod. hard	0.8 Left in Hole (.2) 100	Box 8 984.1 Box 9	1010.0-1009.9, shaly broken 1009.3-1008.7 mech. bkn. w/high angle frac's 1005.5-1005.2 high angle fract. 1005.4-1003.0 very soft Gouge Zone w/shaly frag's.
980.7			CLAYSHALE, mod. hard, dk. gray, sandy, occ. slk. and calc. incl.			1005.0-1004.4 open, hi angle slick joint
979.7			SANDSTONE, hard, med to lt. gr. silty			1004.4-1003.6 bkn. along fract's
970.5			SILTSHALE, mod. hard, dk. gr. occ. sandy & limy, w/hard calc. inclusions and interbd. clayshale.	100 100 100	976.8 Box 10 970.5	1003.4-1003.1 bkn. along fract's. 1003.1-1002.5, sh., sandy 1002.3, ½" very soft clay seam 1002.3-1001.5 bkn. along non-stained high angle fract's.
			Bottom of Hole			1001.4-1001.0 parting along high angle frac. 999.9 parting @ thin shaly lamination 998.6-998.2 high angle fracture 997.5-997.2 open high angle joint w/ heavy calc. coating. 997.5 open non stained contact. 996.4 shaly, calc. coated parting. 994.3-993.9 parting along high angle frac. 993.6-993.5 bkn siltstone frag's in Clay Matrix, Gouge 992.8-992.7 shaly parting 990.9-990.1 clay shale zone 990.6-990.3, bkn, sh, wd. Lost Water 990.0 Founding El. Mono 12 989.2-988.5 very bkn. w/0.2 loss 986.4-985.9 bkn along high angle frac's 986.0-984.7 overcored 984.7-983.9 overcored bkn, w/dissolution of cementing material. 983.6-983.3 bkn along high angle frac's 982.7-982.5 open low angle joint w/calc. coating 982.5-982.1 calcite healed frac's 981.9 open clay coa. contact, bkn to 981.7 977.5-976.8 CLAYSTONE mod. soft., dk. gray

Hole No. 219

DRILLING LOG	DIVISION: Ohio River	INSTALLATION: Pittsburgh District	SHEET 1 OF 2 SHEETS

1. PROJECT: Stonewall Jackson Lake Dam	10. SIZE AND TYPE OF BIT: 4-inch ID Diamond
2. LOCATION (Coordinates or Station)	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL
3. DRILLING AGENCY: Crown Pressure Grouting Co.	12. MANUFACTURER'S DESIGNATION OF DRILL: Sprague & Henwood 40 C
4. HOLE NO. (As shown on drawing title and file number): 219	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED ---- UNDISTURBED ----
5. NAME OF DRILLER: R. Haddix	14. TOTAL NUMBER CORE BOXES: 8
6. DIRECTION OF HOLE: [X] VERTICAL [ ] INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER: 1019.6 @ compl.
	16. DATE HOLE: STARTED 15 Mar 84 COMPLETED 19 Mar 84
	17. ELEVATION TOP OF HOLE: 1037.7
7. THICKNESS OF OVERBURDEN: wasted core 14.4	18. TOTAL CORE RECOVERY FOR BORING: 99 %
8. DEPTH DRILLED INTO ROCK: core 53.3	19. SIGNATURE OF INSPECTOR
9. TOTAL DEPTH OF HOLE: 67.7	Dave Nugen

ELEVATION 1039.5 (a)	DEPTH (b)	LEGEND (c)	CLASSIFICATION OF MATERIALS (Description) (d)	% CORE RECOVERY (e)	BOX OR SAMPLE NO. (f)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) (g)
1023.3			CORE NOT RETAINED			STARTED SAVING CORE @ 1023.3
1013.3			SANDSTONE, hard, gray, fine-med. grained, w/ angular thin micaceous laminations. 1022.8-1020.2 stained 1022.4-1022.1 slightly angled weathered parting and fracture 1021.5-1021.3 bkn, wd, mic. parting w/ 1/8" brown mic. clay filled parting	100 100	Box 1 1016.3 Box 2	1021.0-1020.5 open high angle clay coated joint 1020.6-1020.5 broken weathered parting. 1017.6 soft-mod hard shaly parting 3/8" thick 1017.6. 1018 original Founding Mono 13, lowered to 1,000 1015.2-1008.5 leached stained 1015.1-1014.7, 45° joint open w/very thin CLAY coating 1014.9 Lost Drill Water going thru rock into diversion channel approx. 40' DS of hole 1014.8 slightly angled micaceous parting. 1013.5 broken parting 1013.3 stained, broken weathered contact 1012.8 weathered, broken stained irregular contact w/soft gray clay 1012.5 stained on open angular contact 1012.4-1012.3 angular conglomerate zone 1011.7-1011.4 broken sandstone zone 1011.3-1011.1 broken w/ gray clay coa. on angular parting 1010.7-1010.4 slightly angled stained parting 1009.8 irregular shaly parting 1009.3 broken stained, wd, parting w/tract gr. clayey coating
1012.8			CLAYSTONE, soft-mod. hard med. gr., silty	100		
1012.5			SANDSTONE, hard fine-med g			
1010.3			SILTSTONE, mod hard, med gr., sandy w/occ. slk's. stained on fractures		1009.1	
1009.5			SANDSTONE, mod. hard, gr. silty fine g. w/silty lam's	100	Box 3	
1006.1			SILTSTONE, mod hard, gr., sandy, occ clayey, occ slks			
1004.4			CLAYSTONE, soft-mod hard, dk. gr. slickensides			
1003.8			SILTSTONE, carb., soft to mod. hard, dk. gr. cl., slk. pyrite	100		
1003.2			COAL,		Box 4	
1001.5						
1000.8			SILTSTONE, mod hard, dk. gr. sandy	83		
1000.4						
998.6			CLAYSTONE, soft med. gray		995.5	
			SILTSTONE, mod. hard, dk. gray	100	Box 5	
991.9			SANDSTONE, mod. hard, med gr, fine grained, silty			
990.4			SILTSTONE, hard, dk. gr., sandy, w/occ. tan calc inc	92.5	988.8	
			CLAYSTONE, mod hard, dk gr			
			SANDSTONE			

DRILLING LOG (Cont Sheet) | ELEVATION TOP OF HOLE 1037.7 | **Hole No.** 219

PROJECT: Stonewall Jackson Dam | INSTALLATION: Pittsburgh District | SHEET 2 OF 2 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f
985.5			SANDSTONE, hard, gr, fine grained, silty, mic., more silty w/depth	100	Box 6
982.5			SILTSTONE, mod. hard, dk. gr. silty, clayey	100	
981.5			SANDSTONE, mod. hard, med. gr., fine grained, sl., w/thin mic. lam.		981.5
987.6			SILTSHALE, mod. hard, dk. gr. w/scat calc. incl.	100	Box 7
972.2			SILTSTONE, mod hard-hard, med-dk. gr., silty, sandy, w/hard calc. inclusions	100	974.5 Box 8
970.0			INDURATED CLAY, very soft-mod hard, red-gr., slk, w/scat calc incl.	100	
			Bottom of Hole		

REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g

1009.1-1007.3 SANDSTONE silty, f. grained, mod. hard
1008.5-1008.0, healed high angle fracture
1008.0-1007.7 slick broken fracture
1006.5 parting along CLSH lamination
1005.6-1005.3 smooth open hi angle joint
1005.3 becoming dk. gr., fissile, slickensided
1004.9-1004.4 crushed w/very soft gr. CLAY
1004.1-1003.8 carb streaks
1001.5-irregular open contact
1001.1-1000.8 broken
999.4-998.9 very silty
999.0-998.8 mech. bkn w/0.1 core loss
991.4-990.9 broken w/0.3 loss and some grout silty below 990.9
990.40 Open Contact
990.0 Founding El. Mono 12
988.2 sli, angular parting.
986.3-985.8 open hi. angle, non-sta. joint
985.5 Tight Contact
984.9-984.5 mech bkn.
980.9-980.5 mech broken.
977.8-977.2 high angle open irregular open joint w/trace pyrite
974.0-973.3 mod. hard, med. gr. CLAYSTONE slickensided, w/hard nodules.
973.4-972.2 slightly sandy, w/hi angle to vert. open irregular joint 973.5 971.7
971.6-971.3 high angle slick DF
971.0-970.5, bkn, crumbly
970.5-970.0 Gouge reddish-brown w/hard SILTSTONE frags, calcareous frags, limy overall

Hole No. 220

DRILLING LOG	DIVISION Ohio River	INSTALLATION Pittsburgh District	SHEET OF 1 SHEETS

1. PROJECT Stonewall Jackson Dam	10. SIZE AND TYPE OF BIT 4" Diamond
2. LOCATION (Coordinates or Station) 5' D/S of Stilling Basin Rt. Side End Sill	11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL
3. DRILLING AGENCY Crown Pressure Grouting Co.	12. MANUFACTURER'S DESIGNATION OF DRILL Sprague & Henwood Model 40C
4. HOLE NO. (As shown on drawing title and file number) 220	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED ---- UNDISTURBED ----
5. NAME OF DRILLER R. Haddix	14. TOTAL NUMBER CORE BOXES 3
6. DIRECTION OF HOLE [X] VERTICAL [ ] INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER 999.6
	16. DATE HOLE STARTED 20 March 84 COMPLETED 20 March 84
7. THICKNESS OF OVERBURDEN 0	17. ELEVATION TOP OF HOLE 1000.6
8. DEPTH DRILLED INTO ROCK 21.0	18. TOTAL CORE RECOVERY FOR BORING 95 %
9. TOTAL DEPTH OF HOLE 21.0	19. SIGNATURE OF INSPECTOR Dave Nugen

ELEVATION a 1000.6	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
998.6			COAL, REDSTONE, black, block, pyritic	50	Box 1	1000.6-998.7 broken with 1.0 loss
997.4			CLAYSTONE, silty, shaly, mod. hard, dk. gray	100		999.6 WATER LEVEL 998.7 0.1 pryite vein
989.5			SILTSTONE, mod hard to hard, shaly, dk. gray, interbedded w/SANDSTONE hard, fine grained, gr., occasional low angle bedding plane fractures	100 100	993.8 Box 2	997.4 core spin 994.7-994.2 shaly 994.2 sli. wd. horz. parting w/trace gr. clayey coating, soft
987.0			SILTSHALE, soft to mod. hard, dk. gr, w/tan calc nod., occ. slickensides	100	986.5	987.0-986.8 fractured CLAYSHALE
986.5			CLAYSTONE, soft, wd, bkn.			
984.6			SANDSTONE, hard, gray fine to med. grained	100	Box 3	984.6 open contact 982.8 becoming sandy w/ SS lam.
982.0			SILTSTONE, clayey, mod. hard, dk. gr., calc. incl			982.0-981.6 open high angle joint
980.3			SANDSTONE, hard, lt to med. gr., silty, micaceous	89		980.6 and 980.3 open parting, shaly lam.
979.6			SILTSHALE, mod. hard, dk. gr., w/scat. clac. no d's.		979.6	
						Bottom of Hole

Hole No. 221

DRILLING LOG	DIVISION: Ohio River	INSTALLATION: Pittsburgh District	SHEET 1 OF 1 SHEETS

1. PROJECT: Stonewall Jackson Dam	10. SIZE AND TYPE OF BIT: 4" ID Diamond
2. LOCATION (Coordinates or Station): 5' DN/ST Stilling Basin End Sill LF. Side	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL
3. DRILLING AGENCY: Crown Pressure Grouting	12. MANUFACTURER'S DESIGNATION OF DRILL: Sprague & Henwood 40C
4. HOLE NO. (As shown on drawing title and file number): 221	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED ---- UNDISTURBED ----
5. NAME OF DRILLER: R. Haddix	14. TOTAL NUMBER CORE BOXES: 3
6. DIRECTION OF HOLE: [X] VERTICAL [ ] INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER: 998.5
	16. DATE HOLE: STARTED 22 March 84; COMPLETED 22 March 84
7. THICKNESS OF OVERBURDEN: 0	17. ELEVATION TOP OF HOLE: 999.4
8. DEPTH DRILLED INTO ROCK: 20.4	18. TOTAL CORE RECOVERY FOR BORING: 98 %
9. TOTAL DEPTH OF HOLE: 20.4	19. SIGNATURE OF INSPECTOR: Dave Nugen

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
999.4						
997.8			CLAYSTONE, soft-mod. hard, dk. gr.	94	Box 1	998.4-998.1 very soft w/wd. parting @ 998.2
996.1			SILTSTONE, soft-mod hard, shaly, dk. gr. interbedded			997.7-997.5 mech bkn
995.4			w/hard, gr. SANDSTONE	84		
995.0			SILTSHALE, mod hard, dk. gr.	100	992.7	997.3-997.2 open partings
			CLAYSTONE, soft-mod hard			
992.0			SILTSTONE, hard, sandy med. gr. w/interbd. SS			996.5 shaly parting
987.7			SILTSHALE, sandy, soft, to mod. hard, dk gr. w/ calc. nodules.	100	Box 2	996.1-995.8 loss 995.4-995.0 mech. bkn. w/nodules
987.4			CLAYSTONE, soft, slick, bkn	100	985.5	987.4 ½" black sli. band.
984.0			SANDSTONE, silty, fine grained, hard			980.4-980.3 sandy lens
983.3			SILTSTONE, hard, gr., sandy sl. shaly		Box 3	979.5 tight low angle contact
980.3			SILTSHALE, mod. hard-hard, dk. gr., w/calc nodules	100		
979.5			SILTSTONE, sandy, mod. hard, gray-grades to SS		979.0	
979.0			SANDSTONE, hard, fine to med grained			Bottom of Hole

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PROJECT: STONEWALL JACKSON DAM | HOLE NO. 221

Hole No. 222

DRILLING LOG

DIVISION	Ohio River
INSTALLATION	Pittsburgh District
SHEET	1 OF 2 SHEETS
1. PROJECT	Stonewall Jackson Lake Dam
2. LOCATION (Coordinates or Station)	Mono 12 Dwst. Center
3. DRILLING AGENCY	Crown Pressure Grouting
4. HOLE NO. (As shown on drawing title and file number)	222
5. NAME OF DRILLER	R. Haddix
6. DIRECTION OF HOLE	[X] VERTICAL [ ] INCLINED ______ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN	Wasted Rock 33.2
8. DEPTH DRILLED INTO ROCK	Core 25.0
9. TOTAL DEPTH OF HOLE	58.2
10. SIZE AND TYPE OF BIT	4-inch Diamond
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	MSL
12. MANUFACTURER'S DESIGNATION OF DRILL	Sprague & Henwood-Model 40c
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN	DISTURBED: --- UNDISTURBED: ---
14. TOTAL NUMBER CORE BOXES	4
15. ELEVATION GROUND WATER	1007.7
16. DATE HOLE	STARTED: 25 Sept 84 COMPLETED: 27 Sept 84
17. ELEVATION TOP OF HOLE	1038.2
18. TOTAL CORE RECOVERY FOR BORING	97 %
19. SIGNATURE OF INSPECTOR	Dave Nugen

ELEVATION a 1038.2	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			ROCK NOT SAMPLED			
1005.0						1007.2-1005.2 REDSTONE COAL
1002.7			CLAYSTONE, soft-mod. hard, med. gr., shaly, silty	100	Box 1	Gray clay filled partings @ 1004.3, 1004.2, 1004.0
			SANDSTONE, mod. hard, med. gr., w/dk. gray silty laminations, fine grained, silty	100	998.1	1003.2, 1002.9 low ang. slightly wd. joints 1002.7-1002.2 open high angle joint 1002.1-1002.0 open sli. wd. siltstone lam. or low angle DF
994.0				100	Box 2	1000.4 wd. silty lam. 995.9 wd. silty lam.
992.8			SILTSTONE, sandy grading to			995.4 grading very silty
992.0			sandy SILTSHALE, mod.hard, dk. gr., w/calcite filled frac's			995.0 open shaly parting 992.8-990.6 SHEAR ZONE
			CLAYSTONE SHEAR ZONE w/gr. clay matrix & SS frags	86.2	990.2	992.0-991.5 open high angle joint, calc. coating
			SANDSTONE, hard, gray	(0.8)		

DRILLING LOG (Cont Sheet)	ELEVATION TOP OF HOLE 1038.2		Hole No. 222
PROJECT STONEWALL JACKSON DAM	INSTALLATION Pittsburgh District		SHEET 2 OF 2 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			SANDSTONE, Hard, gray fine grained, silty, with SILTSTONE laminations	100	Box 3	991.5 CLAY coated angular parting 991.5-990.6 broken sheared w/0.6 loss 989.0-988.5 SHEAR ZONE w/angular contact, soft wd. CLAYSTONE w/SS frags, overdrilled
					984.0	
980.9				90 (0.4)	Box 4	
980.4			SILTSTONE, mod. hard, gray, shaly			988.5-987.4 very bkn, fractured, recemented breccia, overdrilled w/dissolution of cementing material 987.2-986.8 carb. inclusion 986.3-986.0 shaly SILTSTONE 985 UFR 982.8-981.5 partings along low angle fract. & silty laminations 982.0 becoming very silty 980.9 angular shear 980.9-980.4 mech. broken 0.4 left in hole.
			BOTTOM OF HOLE			

Hole No. 223

DRILLING LOG

- DIVISION: Ohio River
- INSTALLATION: Pittsburgh
- SHEET: of SHEETS
- 1 PROJECT: Stonewall Jackson Lake Dam
- 2 LOCATION (Coordinates or Station): MONO 13 DNST Center
- 3 DRILLING AGENCY: Crown Pressure Grouting
- 4 HOLE NO. (As shown on drawing title and file number): 223
- 5 NAME OF DRILLER: R. Haddix
- 6 DIRECTION OF HOLE: X VERTICAL ☐ INCLINED ______ DEG. FROM VERT.
- 7 THICKNESS OF OVERBURDEN: Wasted Rock 10.3
- 8 DEPTH DRILLED INTO ROCK: Core 60.4
- 9 TOTAL DEPTH OF HOLE: 70.7
- 10 SIZE AND TYPE OF BIT:
- 11 DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL
- 12 MANUFACTURER'S DESIGNATION OF DRILL: Sprague - Henwood 40-C
- 13 TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED --- UNDISTURBED ---
- 14 TOTAL NUMBER CORE BOXES: 9
- 15 ELEVATION GROUND WATER: 1009.0
- 16 DATE HOLE: STARTED 2 Oct 84 COMPLETED 4 Oct 84
- 17 ELEVATION TOP OF HOLE: 1040.3
- 18 TOTAL CORE RECOVERY FOR BORING: 99 %
- 19 SIGNATURE OF INSPECTOR: Dave Nugen

ELEVATION (a) 1040.3	DEPTH (b)	LEGEND (c)	CLASSIFICATION OF MATERIALS (Description) (d)	% CORE RECOVERY (e)	BOX OR SAMPLE NO. (f)
1030.0			ROCK NOT SAMPLED		
1019.2			SANDSTONE, hard, lt. gr., fine-med gray, micaceous, x-bedded, w/dark gray low angle silty laminations, occ. partings on silty and micaceous laminations	100 100	Box 1 1022.8 Box 2
1017.4			CLAYSTONE, soft-mod. hard, gray, silty, shaly	98	
1016.5			SILTSTONE, mod. hard, gray, slightly sandy		1015.8
1009.6			SANDSTONE, mod. hard, med. gray, fine grained	100	Box 3
1008.2			CLAYSTONE, soft, dk. gray slickensided w/SHEAR zone	100	Box 4
1005.7			COAL, REDSTONE, black, blocky pyritic		
1003.3			CLAYSTONE, mod. soft-mod. hard, gray, pyritic grading sandy	100	
1002.3			SANDSTONE, mod. hard, med. gray, fine grained, silty		1002.0
1002.0			CLAYSTONE, soft-mod, hard slk		
996.2			SANDSTONE, mod. hard, gray, fine grained, silty interbd. w/dk. gr. mod soft shaly SILTSTONE, occ. shaly along shaly lam	100	Box 5
993.2			SILTSHALE, mod. hard, dk. gr, w/calc. inclusions	100	995.1
992.8			CLAYSTONE, mod hard, dk gr		
			SANDSTONE, mod. hard-hard		

REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) (g)

1021-1020.5 open high angle stained joint
1019.7-1019.2 silty incl.
1018.9-1017.2 very bkn on high angle stained fracture
1018.5-1018.3 clay filled frac.
1018.2-1017.7 open, stained, high angle joint
1015.2-1014.9 SILT SILTSTONE zone w/calc. healed irregular VF
1014.8-1013.2 open bkn, high angle joint set
1013.2-1012.2 fractured SILTSTONE zone w slick clay coating
1012.2 high angle slick parting
1012.1-1011.1 SHEAR zone SS frags in CLAY matrix
0.2 spun core @ 1010.6
1010.6-1009.8 SILTSTONE zone, mod. hard, sandy
1009.9-1009.6 slick broken fracture
1009.5-1009.0 broken SHEAR zone w/gray CLAY @ 1009.2-1009.0
1008.9-1008.2 carb zones & high angle healed fract

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PROJECT: STONEWALL JACKSON DAM HOLE NO. 223

DRILLING LOG (Cont Sheet) ELEVATION TOP OF HOLE 1040.3 **Hole No.** 223

PROJECT: STONEWALL JACKSON DAM | INSTALLATION: Pittsburgh District | SHEET [illegible] OF [illegible] SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
986.7			SANDSTONE, mod. hard-hard, fine grained, silty, lt. to dk gr. micaceous w/dk. gr. SILTSTONE lam's.	100	Box 6 988.3	1008.2-1007 8 bony coal, transition zone 1005.5-1005.0 high angle diag slick fract.
984.9			CLAYSTONE, soft-mod hard, dark, gr., shaly, slick on partings, grading sandy	100	Box 7	1000.8 core overdrilled 993.2-992.9 bkn, slick 990.1-988.9 very silty
983.1			SANDSTONE, silty, hard, dk. gr. fine grained		981.3	987.4-986.6 broken along closely spaced, irreg. high angle fract
980.5			SILTSHALE, mod. hard, dk. gr., w/hard tan inclusions			986.7-1/4" CLAY GOUGE on contact
979.7						
978.4			CLAYSTONE, mod. hard, dk. gr., w/hard LIMESTONE incl.	86	Box 8	980.5-980.1 very hard LIMESTONE w/high angle fracture
976.7			SILTSTONE, mod. hard, sandy med. gr., calc. incl. shaly pa's.	(0.6)	974.5	978.7-978.6, low angle fracture
975.0			SHEAR ZONE, SILTSTONE frags in gray clay matrix(0.6 loss)	100		
973.9			CLAYSTONE, mod. hard, dark, gray w/hard calc. incl		Box 9	976.1-978.5 limestone lens
969.9			SANDSTONE, hard, silty, fine grained, gray	100	969.6	973.9-973.6 shaly CLAYSTONE zone
969.6			SILTSTONE, mod. hard, shaly, sandy, gr. w/calc. incl.			BOTTOM OF HOLE
			CLAYSHALE, mod. hard, dk. gr. w/ironstone incl.			

SUBSURFACE EXPLORATION
PRESSURE TEST DATA

BORING SIZE	ELEVATION TOP OF HOLE	ELEVATION TOP OF ROCK	STATIC WATER LEVEL
5½" DIAMETER	1040.0	1040.0	30.7' (1009.3)

PUMP CAPACITY	METER TYPE	METER SERIAL NUMBER
22.9 G.P.M.	BUFFALO METER COMPANY	6547826

FIELD TEST DATA

TEST SECTION		GAUGE READING (P.S.I.)	TIME OF TEST			METER READING		TOTAL WATER Cu. Ft.)	C. F. M.
TOP DEPTH	BOTTOM DEPTH		START	END	INTERVAL (Min.-Sec.)	START OF TEST	END OF TEST		
Check Pump Capacity			1020	1025	5 min.	20.0	134.5	114.5	3.06
Double Packer									
50.0	55.5	24	1104	1109	5 min.	240.0	240.0	--	--
43.15	48.0	22	1150	1155	5 min.	380.0	443.5	63.5	1.70

PROJECT	BORING NO.	INSPECTOR	DATE
STONEWALL JACKSON DAM	223	DAVID NUGEN	10 October 84

ORH FORM 2142 (HED Fsm 1110.1.1)
1 DEC 68

Hole No. 225

DRILLING LOG	DIVISION: Ohio River Division	INSTALLATION: Pittsburgh District	SHEET 1 OF 2 SHEETS
1. PROJECT: Stonewall Jackson Lake Dam		10. SIZE AND TYPE OF BIT: 4-inch Diamond	
2. LOCATION (Coordinates or Station): Mono Jt. 12-13 DNST		11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL	
3. DRILLING AGENCY: Crown Pressure Grouting Co.		12. MANUFACTURER'S DESIGNATION OF DRILL: Sprague & Henwood 40-C	
4. HOLE NO. (As shown on drawing title and file number): 225		13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED ---	UNDISTURBED ---
5. NAME OF DRILLER: R. Haddix		14. TOTAL NUMBER CORE BOXES: 5	
6. DIRECTION OF HOLE: [X] VERTICAL [ ] INCLINED ____ DEG. FROM VERT.		15. ELEVATION GROUND WATER: 1012.8	
7. THICKNESS OF OVERBURDEN: Wasted Rock 19.0		16. DATE HOLE: STARTED 20 Sept 84	COMPLETED 24 Sept 84
8. DEPTH DRILLED INTO ROCK: Core 35.6		17. ELEVATION TOP OF HOLE: 1039.2	
9. TOTAL DEPTH OF HOLE: 54.6		18. TOTAL CORE RECOVERY FOR BORING: %	
		19. SIGNATURE OF INSPECTOR: Dave Nugen	

ELEVATION a (1039.2)	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
1020.2			ROCK NOT SAVED			
1014.5			SANDSTONE, mod. hard to hard, gray, fine to med grained	100	Box 1	1020.2-1017.7 brown stained 1020.2-1019.6 brown clay coated angular parting 1019.2-1018.8, 1018.5-1018.1, 1018.1-1017.7 high angle joints, stained & clay coated 1017.1-parting along 1/4 inch silty lam. 1014.5-1014.2 mech. bkn on wd. fract.
1013.1			SILTSTONE, mod. hard, med. gray w/tan inclusions, sandy	100	1012.9	1013.4-1013.2 fract., vert. wd. open 1013.1 wd. clay coated contact
1008.7			SANDSTONE, mod. hard, med gray fine grained, silty, crossbedded interbedded w/ med. gray SILTSTONE		Box 2	1011.4-1010 open, wd. fracts 1010-1009.2 ve. bkn, slick SHEAR 1008.7-1008.1 bkn, slightly wd., slick
1005.0			SILTSTONE, mod. hard, med. gray slickensided w/occ. SANDSTONE zones	100	1005.9	1007.4-1007.3 high angled fract., some healed 1005.9-1005.7 loss 1005 wd. shear contact
1004.0			CARB. SHALE & SANDSTONE, mod hard, interbedded	96	Box 3	
1003.6			COAL - REDSTONE, black, blocky, pyr.	(0.2)		
1003.2			SHALE, mod. hard, dk. gray, carb.			1002.6-1002.1 CLAYSTONE 1002.5-1002.1 open, high angle, clay coated shear plane
1000.0			SILTSTONE, soft to mod hard, med gray, sandy, occ. grading to CLAYSTONE at top	100	998.6	1000.1 sli. wd. parting
			SANDSTONE, mod. hard to hard, med. gray w/dark gray silty laminations & zones, fine grained, silty, harder and micaceous below 991.0	100	Box 4	997.4 shaly parting 992.8-992.1 SILTSTONE, shaly 992.0-991.8 CLAYSTONE, soft, shear, bkn, fract w/clay seam
				100	991.6	

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE | PROJECT | HOLE NO

DRILLING LOG (Cont Sheet)	ELEVATION TOP OF HOLE 1039.2		Hole No. [illegible]
PROJECT STONEWALL JACKSON DAM	INSTALLATION Pittsburgh District		SHEET 2 OF 2 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			SANDSTONE, cont.		Box 5	
984.6				100	984.6	
			BOTTOM OF HOLE			

ENG FORM 1836-A JUN 67

PROJECT	HOLE NO
STONEWALL JACKSON DAM	[illegible]

Hole No. 224

DRILLING LOG	DIVISION Ohio River Division	INSTALLATION Pittsburgh District	SHEET 1 OF 2 SHEETS

1. PROJECT Stonewall Jackson Lake Dam	10. SIZE AND TYPE OF BIT 4-inch Diamond
2. LOCATION (Coordinates or Station) Mono jt. 12-13 DNST.	11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL
3. DRILLING AGENCY Crown Pressure Grouting	12. MANUFACTURER'S DESIGNATION OF DRILL Sprague & Henwood 40-C
4. HOLE NO. (As shown on drawing title and file number) 224	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN — DISTURBED --- UNDISTURBED ---
5. NAME OF DRILLER R. Haddix	14. TOTAL NUMBER CORE BOXES 5
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER ---
	16. DATE HOLE — STARTED 18 Sept 84 — COMPLETED 19 Sept 84
7. THICKNESS OF OVERBURDEN Wasted Rock 19.6	17. ELEVATION TOP OF HOLE 1039.6
8. DEPTH DRILLED INTO ROCK Core 35.0	18. TOTAL CORE RECOVERY FOR BORING %
9. TOTAL DEPTH OF HOLE 54.6	19. SIGNATURE OF INSPECTOR Dave Nugen

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
1039.6			ROCK NOT SAVED			
1020.0						
1015.6			SANDSTONE, hard, gray, fine-med. grained, silty 1020.0-1019.6 highly wd. stained, broken	100	Box 1	1017.7 parting on silty lamination 1016.1-1015.6 scattered silty inclusions
1014.5			SILTSTONE, mod. hard, gr. w/calcite filled fracture	98	1013.2	1015.6-1014.3 calcite healed vertical joint in silty zone
1011.2			SANDSTONE, mod. hard, gray, fine grained, silty, occ. x-bd.			1014.3-1013.9 broken hi angle fractures
1010.4			SILTSTONE, soft-mod hard, clayey, shaly, gr., slickensided	(0.1)	Box 2	1013.5-1013.2 frac's. w/clay coating, rusty @ 1013.4
1009.9			SANDSTONE, fine-med. grained, silty	100		1012.7-1012.1 dk. shaly lam. grading to slick
1008.2			SILTSTONE, soft-mod. hard, gr., sandy shaly		1006.3	CLAYSTONE lens w/hard calc. inclusions
1007.5			SILTSHALE, mod. hard, slick, carb., broken	100	Box 3	1011.0 gray clay filled parting
1005.5			COAL, - REDSTONE, blocky pyritic, bkn. below 1006.3			1011.0-1010.7 bkn., slick
1002.4			SILTSTONE, soft-mod. hard med. gr. silty, clayey, slk.			1009.9-1009.5 high to low angle fractures
994.3			SANDSTONE, mod. hard-hard, med. gr., fine grained, silty, micaceous, interbd., w/dk. gr. SILTSTONE laminations	100 96	993.3 Box 4	1008.9-1008.5 sandstone lens 1009.6-1007.5 sandstone lens, moderately hard 1007.5-1007.3 bony COAL w/SS laminations
993.2			CLAYSTONE, soft-mod. hard, very bkn, shaly, slk		992.1	
			SANDSTONE, mod. hard-hard, gray, fined grained	100		

DRILLING LOG (Cont Sheet)	ELEVATION TOP OF HOLE 1039.6	Hole No. 224
PROJECT Stonewall Jackson Dam	INSTALLATION Pittsburgh District	SHEET 2 OF 2 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
985.4			SANDSTONE, cont'd, silty, micaceous, interbd w/SILTSTONE lam. grading to sandy SHALE	100	Box 5 985	1005.5-1005.3 high angle slick contact in claystone zone 1003.1-1002.7 sandstone lens
985.0			SHALE, soft, clayey, dk. gr., mech. bkn.			1002.2 UFR 1000.4-1000.1, courser grained
			BOTTOM OF HOLE			

ENG FORM 1836-A JUN 67 | PROJECT STONEWALL JACKSON DAM | HOLE NO

Hole No. 226

DRILLING LOG	DIVISION: Ohio River Division	INSTALLATION: Pittsburgh	SHEET OF SHEETS

1. PROJECT: STONEWALL JACKSON LAKE DAM	10. SIZE AND TYPE OF BIT: Diamond
2. LOCATION (Coordinates or Station): MONO JT 13-14	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL
3. DRILLING AGENCY: Crown Pressure Grouting Co.	12. MANUFACTURER'S DESIGNATION OF DRILL: Sprague & Henwood 40-C
4. HOLE NO (As shown on drawing title and file number): 226	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED --- UNDISTURBED ---
5. NAME OF DRILLER: R. Haddix	14. TOTAL NUMBER CORE BOXES: 7
6. DIRECTION OF HOLE: [X] VERTICAL [ ] INCLINED ____ DEG. FROM VERT	15. ELEVATION GROUND WATER: 1009.3
7. THICKNESS OF OVERBURDEN: Wasted Rock 10.7	16. DATE HOLE: STARTED 5 Oct 84, COMPLETED 9 Oct 84
8. DEPTH DRILLED INTO ROCK: Core 44.8	17. ELEVATION TOP OF HOLE: 1040
9. TOTAL DEPTH OF HOLE: 55.5	18. TOTAL CORE RECOVERY FOR BORING: 100 %
	19. SIGNATURE OF INSPECTOR: Dave Nugen

ELEVATION (a)	DEPTH (b)	LEGEND (c)	CLASSIFICATION OF MATERIALS (Description) (d)	% CORE RECOVERY (e)	BOX OR SAMPLE NO. (f)
1040.0					
1029.3			ROCK NOT SAVED		
1015.4			SANDSTONE, hard, light gray, fine to med. grained w/dark gray, thin, micaceous laminations, occ. partings on silty laminations	100	Box 1
				100	1022.3
					Box 2
				100	1015.5
1014.2			SILTSTONE, SHEAR zone, very bkn w/occ. clay seams		
1007.3			SANDSTONE, mod. hard to hard, gray, fine grained, silty	100	Box 3
					1008.9
1006.2			CLAYSTONE, mod. hard, dk gray sandy w/carb. stages and shear zone	100	Box 4
1005.5			SILTSTONE, mod. hard, sandy w/carb. stages and bony coal	100	
1003.6			COAL, -REDSTONE, black, blocky, pyritic		1002.0
1001.2			CLAYSTONE, mod. hard med. gray silty, slickensided		Box 5
998.2			SANDSTONE, mod. hard to hard med. gray, fine grained, silty	100	
997.5			CLAYSTONE, mod. soft to mod hard, med. gray		995.0
			SANDSTONE, mod. hard to hard, gray, fine to med. grained, silty w/mod. hard, dk. gray, SILTSTONE laminations, occ. micaceous bedding w/ associated fracturing	100	Box 6

REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) (g):

1028.8-1024.2 stained
1027.9-1026.9 open, wd. high angle, joint
1016.2-1015.4 silty inclusions
1016.2, 1015.7, 1015.5 irreg. clay coated partings
1015.7-1015.5 high angle frac.
1014-1013.3 healed, high angle fracture
1013.4 sil. wd. parting @ silty lamination
1012.8-1012.3 high angle fracts., partially open
1012.1-1011.0 open, high angle joints
1011.0 hor. clay coated part.
1010.7-1010.5 45° joint
1010.2 horz. shaly parting
1010.1-1009.7 high angle tight fract
1009.3-1008.8 irreg. shaly parting w/gray clay coating
1008.5-1008.4 bkn, shaly part.
1007.8-1007.0 open, high angle joints
1007.3-1007.0 lithologic change along high angle joint
1007-1006.6 SHEAR zone, soft clay w/shale frags.
1003.7-1003.6 COAL, bony
1003.7-1003.5 bkn w/gray clay coating
1001.6 & 1001.5 slick part.
1000.7-1000.5 CLAYSTONE lam.
1000.5-999.6 open, high angle, irreg. joint; non-stained
997.6 open shear plane

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE | PROJECT STONEWALL JACKSON LAKE DAM | HOLE NO. 226

DRILLING LOG (Cont Sheet) ELEVATION TOP OF HOLE 1040.0 Hole No. [illegible]

PROJECT: STONEWALL JACKSON DAM | INSTALLATION: Pittsburgh District | SHEET [illegible] OF [illegible] SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			SANDSTONE, cont.	100	987.4	994.2-993.8 open, high angle joint-lost water
					box	991-990.6 transition zone, SHALE
					-	991.5-991.0 mech. bkn SS
984.5				100	984.5	990.8 low angle irreg. part.

BOTTOM OF HOLE

PRESSURE TEST DATA

TEST NO.	DEPTH FROM	DEPTH TO	ELEV. FROM	ELEV. TO	TIME	METER START	READ END	TOTAL WATER (Gallons)	CFM	GPM
1	50.0	55.5	990.0	984.5	5 min	240	240	---	---	---
2	43.15	48.0	996.85	992.0	5 min	380	443.5	63.5	1.7	12.7

Hole No. [illegible]

DRILLING LOG	DIVISION Ohio River	INSTALLATION Pittsburgh	SHEET [illegible] OF [illegible] SHEETS

1. PROJECT: Stonewall Jackson Dam	10. SIZE AND TYPE OF BIT: 6-inch ID DIA
2. LOCATION (Coordinates or Station): Sta 5+73.5 - on ℄	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL
3. DRILLING AGENCY: B.H. Mott & Sons	12. MANUFACTURER'S DESIGNATION OF DRILL: CME 55
4. HOLE NO. (As shown on drawing title and file number): [illegible]	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED N/A; UNDISTURBED N/A
5. NAME OF DRILLER: Steve Sawyers	14. TOTAL NUMBER CORE BOXES: [illegible]
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ______ DEG. FROM VERT.	15. ELEVATION GROUND WATER: Artesian
	16. DATE HOLE: STARTED 10 May 85; COMPLETED 11 May 85
7. THICKNESS OF OVERBURDEN: 0 - El.984.6	17. ELEVATION TOP OF HOLE: 984.6
8. DEPTH DRILLED INTO ROCK: 25.2	18. TOTAL CORE RECOVERY FOR BORING: [illegible]
9. TOTAL DEPTH OF HOLE: 24.8-El.959.8	19. SIGNATURE OF INSPECTOR: D. Nugen

ELEVATION (a)	DEPTH (b)	LEGEND (c)	CLASSIFICATION OF MATERIALS (Description) (d)	% CORE RECOVERY (e)	BOX OR SAMPLE NO. (f)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) (g)
984.6			SILTSTONE, m.hard, med. gray shaley, clay, mech bkn 884.6 - 882.9	time 49m		0.1 lost core, mech
982.9				loss 0.1		
			SANDSTONE, m. hard-hard fine grained, gray w/thin dark shaly lam & occ tan silty nodles		[illegible]	Parting along slightly wd. shaley lam 982-981 b w open low ang. cal. coa. joint 981.9-98[illegible]
981.[illegible]			CLAYSTONE, mod hard, dk gr. shaley, w scat tan silty nod	[illegible]2m		bkn silty [illegible] mech. partings [illegible] and 97[illegible]
[illegible]			SILTSTONE, soft-mod hard, sandy w occ. tan. mod. irregular parting 977.6	0.3	[illegible]	
976.[illegible]			CLAYSTONE, soft-mod. hard, dk. gr., silty, shaly, w tan nodules.	[illegible]3m		wd. partings [illegible] snaly lam. 97[illegible] open, high ang, irr. non-sta. [illegible]
97[illegible].9			wd. angular cont.	0		
972.[illegible]			SHEAR ZONE, angular rock rock frags. in fat, gr. clay matrix			0.8 loss from 97[illegible] - 968.3
			INDURATED CLAY, soft, red-gray. 0.1 gray clay SHEAR @ 980.8 with gray claystone 970.8 - 970.5	68m	1[illegible]	bkn, overcored, 96[illegible] - 967.2 w/0.8 loss; wd partings 967.2, 966.8 very bkn 966.5 - 966.
				0.9		
				80m		
				0.5		
966.[illegible]			wd. ? contact		18.8	
			SANDSTONE, mod hard-hard, gr., fine grain, silty wd. horz. pa 963.4	25m 0		open hi. ang. gr. clayey & pyrite coated 96[illegible].3-965.2

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE — PROJECT — HOLE NO.

DRILLING LOG (Cont Sheet) | ELEVATION TOP OF HOLE 984.6 | **Hole No.** 22[illegible]

PROJECT | INSTALLATION Stonewall Jackson | SHEET 2 OF 2 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
964.1			SILTSTONE, s-mod hard			low angle parting 964.1 - 963.7
			INDURATED clay, soft-mod.hard red-gray, slickensided wd. slickensided parting @ 963.0, 962.0, 961.2-960.7	54 m	22.1	broken 964.1 - 963.7
959.8			mech bkn 960.1 - 959.8	0.2	24.8	
						0.4 core left in hole Artesian Flow at completion

ENG FORM 1836-A JUN 67 | PROJECT Stonewall Jackson | HOLE NO. 22[illegible]

Hole No. 228

DRILLING LOG	DIVISION Ohio River	INSTALLATION Pittsburgh District	SHEET 1 OF 1 SHEETS

1. PROJECT: Stonewall Jackson Dam	10. SIZE AND TYPE OF BIT: 6-inch DIA
2. LOCATION (Coordinates or Station): Sta 3+5 7.8, 2" upst E	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL
3. DRILLING AGENCY: S.H. Mott & Sons	12. MANUFACTURER'S DESIGNATION OF DRILL: CME 55
4. HOLE NO. (As shown on drawing title and file number): 228	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED ----- UNDISTURBED ------
5. NAME OF DRILLER: Steve Sawyers	14. TOTAL NUMBER CORE BOXES
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER: Artesian
	16. DATE HOLE: STARTED 11 May 85 COMPLETED 11 May 85
7. THICKNESS OF OVERBURDEN: 0 - EL 984.4	17. ELEVATION TOP OF HOLE: 984.4
8. DEPTH DRILLED INTO ROCK: 25.9	18. TOTAL CORE RECOVERY FOR BORING
9. TOTAL DEPTH OF HOLE: 24.0 EL960.4	19. SIGNATURE OF INSPECTOR: D. Nugen

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
984.4			SILTSTONE, soft - mod hard gr., clayey, sandy, shaly, very bkn, alone frac plane 984.4 - 983.3 w/0.2 gr clayey filled shear @ 983.5 - 983.3			ve bkn. 983.0 - 981.1 probably area of core loss.
982.0					1	
			SANDSTONE, moderately hard, gr, silty	45m		
981.1					3.8	
			SILTSTONE, soft-mod. hard, gr. sandy, clayey, shaley weathered, irregular, open vertical - high angle joint 981.2 - 979.6 weathered horz parting @ 978.0 w gr. clay shear	10.5	2	bkn along high angle fracture @ 979.4 - 977.7
				32m	7.6	
976.2						
			SHEAR ZONE, angular rock frags in heavy gr. clay matrix			
975.2						
			CLAYSTONE, soft-mod. hard, gr., shaly.		3	broken along high angle weathered fracture w trace gr. clay 974.8 - 974.0
974.0				0		
			SHEAR ZONE		10.9	
972.6						
			CLAYSTONE			
972.3						
			SANDSTONE, mod hard, gr, fine grained, silty	76m	4	45° open joint @ 972.1 - 971.3
971.3						
			INDURATED CLAY, red-brown, soft, slickensided vertical open joint @ 971.1 - 968.8 w/ 0.8 core loss open, high angle joint 968.4 - 968.1		14.4	overcored 970.0 - 968
				22.0	5	
			silty parting @ 966.2 bkn clay coated contact	31m		
966.0						
			SANDSTONE, mod. hard-hard gr, silty w dark gr. silty lam.		18.9	
964.5						

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE | PROJECT | HOLE NO.

DRILLING LOG (Cont Sheet) | ELEVATION TOP OF HOLE 98[illegible] | **Hole No.** [illegible]

PROJECT: STONEWALL JACKSON DAM | INSTALLATION: Pittsburgh District | SHEET OF SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
963.[illegible]			SILTSTONE, soft-mod hard, gray, sandy	[illegible]		Picked up [illegible]
			Indurated Clay, soft-moderately hard, red, gray	60%		mech. bkn. 96[illegible]-960.[illegible]
960.[illegible]				1.[illegible]		
			Bottom of Hole			Pulled off core, ran back but 1.9 left in hole depth drilled was 25.9

ENG FORM 1836-A JUN 67 | PROJECT Stonewall Jackson | HOLE NO.

Hole No 229

DRILLING LOG	DIVISION Ohio River	INSTALLATION Pittsburgh District	SHEET OF SHEETS

1 PROJECT: Stonewall Jackson Dam
2 LOCATION (Coordinates or Station): 5+77.5, 16.8' Ds of E
3 DRILLING AGENCY: E H Mott & Son's
4 HOLE NO (As shown on drawing title and file number): 229
5 NAME OF DRILLER: Steve Sawyers
6 DIRECTION OF HOLE: XX VERTICAL ☐ INCLINED ______ DEG FROM VERT
7 THICKNESS OF OVERBURDEN: 0.0 EL 983.8
8 DEPTH DRILLED INTO ROCK: 22-1
9 TOTAL DEPTH OF HOLE: 19-2 El 964.6
10 SIZE AND TYPE OF BIT: 5-inch DIA
11 DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL
12 MANUFACTURER'S DESIGNATION OF DRILL: CME 55
13 TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED ______ UNDISTURBED ______
14 TOTAL NUMBER CORE BOXES: 5
15 ELEVATION GROUND WATER:
16 DATE HOLE: STARTED 12 May 85 COMPLETED 13 May 85
17 ELEVATION TOP OF HOLE: 983.8
18 TOTAL CORE RECOVERY FOR BORING: %
19 SIGNATURE OF INSPECTOR: D. Nugan

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
983.8			Claystone, soft-mod. hard, gr., silty, shaly w/scat. tan sil. nod.			mech bkn 983.8 - 982.2
982.2						
981.8			Sandstone, mod hard, silty		1	
			Claystone, soft-mod hard, shaly, silty, weathered 981.8 - 981.6 w/trace clay coating	35m		
980.2					3.8	Open horz. contact
			Silstone, mod. hard, dk. gr., clayey w occ. sandy lam's & zones occ. tan silty nod.	10.2		
					2	possible core loss at contact
977.8			Claystone, soft-mod. hard, gr., silty, high angle wd. joint 975.8 - 975.3	38m		
					7.8	Core bkn, spun, poss. loss 976.5 - 975.9
975.3			Shear Zone highly fractured and broken rock with 2.4 core loss between 975.3 - 972.2	12.0		bkn and overcured
				15m	3	
			Siltstone, soft-mod. hard, med. gr.	10.2		hole caving
			Indurated clay, red-brown, soft, mod. hard, fractured	25m		
					14.8	Core spins, 2.4 loss core between 971.4 - 968.7
				13.0	4	
			Sandstone, moderately hard - hard, silty, fine grained	60m		Drilled depth 22.1
						poor core rec'y rec'd new lifter
				11.9	18.6	
			Indurated clay, soft	8m		Slickensided, red.
				10.6	5	
			Bottom of hole			2.9 left in hole

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE PROJECT HOLE NO

Hole No 230

DRILLING LOG	DIVISION: OHIO RIVER	INSTALLATION: Pittsburgh District	SHEET 1 OF 1 SHEETS

1. PROJECT: Stonewall Jackson Dam	10. SIZE AND TYPE OF BIT: 6-inch ID DIA
2. LOCATION (Coordinates or Station): Sta St 76.5, 27.2' DS of ℄	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL
3. DRILLING AGENCY: B. H. Mott & Sons	12. MANUFACTURER'S DESIGNATION OF DRILL: CME 55
4. HOLE NO. (As shown on drawing title and file number): 230	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED ——— UNDISTURBED ———
5. NAME OF DRILLER: Steve Sawyers	14. TOTAL NUMBER CORE BOXES: 5
6. DIRECTION OF HOLE: XX VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER
	16. DATE HOLE: STARTED 13 May 85, COMPLETED 13 May 85
7. THICKNESS OF OVERBURDEN: 0 - EL984.5	17. ELEVATION TOP OF HOLE: 984.5
8. DEPTH DRILLED INTO ROCK: 21.0	18. TOTAL CORE RECOVERY FOR BORING: %
9. TOTAL DEPTH OF HOLE: 19.0 EL 964.1	19. SIGNATURE OF INSPECTOR: D. Nugen

ELEVATION (a)	DEPTH (b)	LEGEND (c)	CLASSIFICATION OF MATERIALS (Description) (d)	% CORE RECOVERY (e)	BOX OR SAMPLE NO. (f)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) (g)
984.5			Sandstone, mod. hard-hard, fine grained, gr.,			Top core mech. bkn.
983.0			open spun contact w/tr.cl.			probable area of 0.2 loss
			Claystone, soft-mod. hard, dk. gr., silty, w/tan silty nodules	77m	1	core spins
981.8			Siltstone, soft-mod. hard, dk. gr., sandy, clayey			
			bkn. w/core spins and trace gr. clay 980.4 - 980.4	10.2		Prob area 0.1 loss
			Shear zone w/2.1 core loss 978.4-975.7	35m	2	
				12.5	9.6	Cave in 13.6
			core bkn into small pc's. w 1.9 loss 974.6 - 971.7	30m	3	Took core barrel apart, tighten nut, inner bbl. had been hanging in core bit
				11.5		
970.6			Wd. open contact			
			Indurated Clay, soft-mod. hard, red-brown, slickensided, w/closely spaced slickensided partings. Very bkn. 969.0 - 967.5 w 0.6 loss	30m	14.7	
				10.5	4	
967.5			Sandstone, mod hard, fine grained, silty, w/dk. thin silty stringers	45m		
966.2			Siltstone, soft - mod. hard, dk. gr.		18.3	bkn. w trace tr. cl. 966.3 - 966.0
965.5			Indurated Clay, soft, mod. hard, red - bn., silk		5	1.1 left in hole drilled depth 21.0
964.6				10.7		Bottom of Hole

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE | PROJECT | HOLE NO

Hole No 23_

DRILLING LOG	DIVISION OHIO RIVER	INSTALLATION Pittsburgh District	SHEET _ OF _ SHEETS

1. PROJECT Stonewall Jackson Dam	10. SIZE AND TYPE OF BIT _ - inch ID DIA
2. LOCATION (Coordinates or Station) Sta 5 & 66 9.8' Ds ℄	11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL
3. DRILLING AGENCY E. H. Mott & Sons	12. MANUFACTURER'S DESIGNATION OF DRILL CME 55
4. HOLE NO. (As shown on drawing title and file number) 231	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN — DISTURBED ---- UNDISTURBED -----
5. NAME OF DRILLER Steve Sawyers	14. TOTAL NUMBER CORE BOXES 6
6. DIRECTION OF HOLE XX VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER
	16. DATE HOLE — STARTED 14 May 85 — COMPLETED 14 May 85
7. THICKNESS OF OVERBURDEN 0.0 EL 983.9	17. ELEVATION TOP OF HOLE 983.9
8. DEPTH DRILLED INTO ROCK 22.5	18. TOTAL CORE RECOVERY FOR BORING %
9. TOTAL DEPTH OF HOLE 21.3 EL 962.6	19. SIGNATURE OF INSPECTOR D. Nugen

ELEVATION (a) 983.9	DEPTH (b)	LEGEND (c)	CLASSIFICATION OF MATERIALS (Description) (d)	% CORE RECOVERY (e)	BOX OR SAMPLE NO. (f)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) (g)
983.4			CLAYSTONE, wd to cl. shaly	21m		fracture 983.2 - 983.0
983.0			SANDSTONE, hard, gr. f. grain	100.1	1	mech. bkn. w/slickensides 983.9 - 982.7
			Claystone, soft - med. hard, dk. gr., silty, w/tan silt nodules. Occ. sandy partings at sand lens 981.5 - 981.4	40 M		
980.1					3.6	
			Sandstone, mod. hard-hard, gr. f. grain, silty			
979.1						
			SILTSTONE, soft-med-hard, dk. gr. sandy w/tan silty nod. low angle frac. 979.1 - 978.	100.0	2	
				1.0	6.9	Mech. bkn. along high angle open joints 978. - 976.8 run blocked.
976.6						
			Shear Zone, 0.7 core loss	25m	3	
973.9						
			Siltstone, soft-mod. hard dk gr. sandy, tan silty nod.			high angle open frac. 973.6 - 972.6
972.6				11.1	11.3	
			Shear Zone 0.8 core loss	40m		Slight water discoloration in holes 227 and 228 during this run
970.9						
			Claystone, soft-mod. hard, gr., silty slickensided parting @ 970.5		4	
968.9				100.5	15.4	
			Indurated Clay, soft-mod. hard, red - bn, gr., slickensided w/ partings @ 968.7, 968.2, 967.6	40m	5	
				100		
966.0			wd. contact	65m		
			Sandstone, mod. hard - hard, fine grain, gr., silty		19.0	Good drill water return
964.0			Wd. contact			

DRILLING LOG (Cont Sheet) | ELEVATION TOP OF HOLE 983.9 | **Hole No.** 23[illegible]

PROJECT Stonewall Jackson | INSTALLATION Pittsburgh District | SHEET 2 OF 2 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			Indurated Clay, soft, red, brown slickensided		6	caving [illegible] bottom hole
962.6				L1.0		
			Bottom of Hole			1.2 left in hole drilled depth 22.5

DRILLING LOG (Cont Sheet) | ELEVATION TOP OF HOLE 983.9 | **Hole No.** 231

PROJECT: Stonewall Jackson | INSTALLATION: Pittsburgh District | SHEET 2 OF 2 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
962.6			Indurated Clay, soft, red, brown slickensided	11.0	6	caving ? bottom hole
			Bottom of Hole			1.2 left in hole drilied depth 22.5

Hole No.

DRILLING LOG	DIVISION	INSTALLATION	SHEET
	O.R.D.	H.L.D.	OF 4 SHEETS

1. PROJECT: Stonewall Jackson Dam	10. SIZE AND TYPE OF BIT: NX Dia. Bit
2. LOCATION (Coordinates or Station): Right Abutment Sta. 1+11.5	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL
3. DRILLING AGENCY: Pennsylvania Drilling Co.	12. MANUFACTURER'S DESIGNATION OF DRILL: Mobile B
4. HOLE NO. (As shown on drawing title and file number): 5C-1	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED --- UNDISTURBED ---
5. NAME OF DRILLER: Jim Lang	14. TOTAL NUMBER CORE BOXES
6. DIRECTION OF HOLE: [X] VERTICAL [ ] INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER
	16. DATE HOLE: STARTED 5-6-86 COMPLETED 5-6-86
7. THICKNESS OF OVERBURDEN: 21.0	17. ELEVATION TOP OF HOLE: 1102.0
8. DEPTH DRILLED INTO ROCK: 85.1	18. TOTAL CORE RECOVERY FOR BORING: 98.4 %
9. TOTAL DEPTH OF HOLE: 106.1	19. SIGNATURE OF INSPECTOR: Richard Yuzen

ELEVATION (a)	DEPTH (b)	LEGEND (c)	CLASSIFICATION OF MATERIALS (Description) (d)	% CORE RECOVERY (e)	BOX OR SAMPLE NO. (f)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) (g)
1081.0	21.0		CLAYSTONE - r.; m.s. to m.h.; bkn. w/m.h. nod. & limey inc.; sl.			0.0 to 21.0 imp. fill auger to 21.0 w/ 3-3/8" hollow stem flight auger
	22					
	23		becoming ve. sl. @ 1079.0			Auger length 21.0' NX core bbl. 10.2'
	24					Note: Run data not received from driller
1077.2			SILTSTONE - m. gr.; m.h.; w cal. fil frac.; limey; sl.			
	25					
	26		becoming ve. sl. & r. @ 1075.7			
	27					
	28		becoming gr. @ 1074.0			
	29		0.5' lost core accum. between 28.5 to 29.4			
1071.7	30		bkn. & sta. 1072.6 to 1070.7			
			CLAYSTONE - m.g.; m.s.; sli. sl.; sli. sh.			
1070.5	31					
			SILTSTONE - m. gr.; m.h.; sa.			
	32		bkn. & sta. 1070.4 to 1069.4			
	33		becoming v. sa.; sli. x-bd. @ 1069.2			
	34					
	35		sta. @ 1066.9 to 1066.6			
	36		vert. frac. & sta. 1066.3 to 1063.9			
	37		sli. x-bd. @ 1064.9 to 1063.8			
	38					
	39					
	40		no sand below 1062.1			
	41					

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DRILLING LOG (Cont Sheet)

ELEVATION TOP OF HOLE: 1102.[illegible]

Hole No. [illegible]

PROJECT: Stonewall Jackson Dam

INSTALLATION: H.E.D.

SHEET [illegible] OF 4 SHEETS

ELEVATION (a)	DEPTH (b)	LEGEND (c)	CLASSIFICATION OF MATERIALS (Description) (d)	% CORE RECOVERY (e)	BOX OR SAMPLE NO (f)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) (g)
1061.0	41.[illegible]					
1060.[illegible]	42		INDURATED CLAY - m. gr. to r.; m.s. to s.; crumbly; slk. pa.			
1056.1	46		SILTSTONE - m. gr.; m.h.; sa.; sm. br. nod.			
	52		becoming cl. @ 1050.0			
1049.3	53		CLAYSTONE - r. to gr.; m.s.; sli. sl.			
1046.0	56		SILTSTONE - m.s. to m.h.			
	57		clayey 1046.0 to 1045.6			
	58		becoming sa. w/h. cal. incl.; hor. pa.; sta. @ 1045.0			
	59		v. bkn. & sta. 1045.5 to 1044.3			
	60		over drilled - 60.1 to 60.3			
	63		clayey bd. @ 1039.0 to 1038.8			
	65					

Depth scale: 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65

DRILLING LOG (Cont Sheet) ELEVATION TOP OF HOLE

Hole No.

PROJECT: ...onewall Jackson Dam — INSTALLATION: H.E.D. — SHEET ... OF 4 SHEETS

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
	66–67		vert. frac. ... to 1035.4			
	67–68		n. br. limey nod. ... to 1034.3			
1032.8	69					
	69–85		CLAYSTONE - gr.; m.s.; sl.; irr. pa.			
	74		not silty below 1027.9; becoming sli. sh.			
	75		becoming red @ 1027.5			
	76		slk. pa. @ 1026.0			
	77		becoming gr. @ 1025.3			
	78		becoming sl. @ 1024.3			
	79–80		n. calc. inc. 1023.3 to 1021.8			
	82–84		c.g. sl. bds.; sli. x-bd. 1020.1 to 1017.8			
	85		limestone nod. @ 1016.8			
	85–89		SILTSTONE - m. gr.; m.h.; sli. sh.; cl. w/cl. intbds.			
	86		f.g. sa. intbd. 1016.5 to 1016.1			

ENG FORM 1836-A

DRILLING LOG (Cont Sheet) ELEVATION TOP OF HOLE 110... **Hole No** ...

PROJECT: Stonewall Jackson Dam — INSTALLATION: H.E.D. — SHEET 4 OF 4 SHEETS

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
1008.7	93					
			INDURATED CLAY - m. gr.; m.s. to s.; crumbly; hi. bkn.			
1006.0	96					
			SILTSTONE - lt. gr.; m.h.; sh.			
	100		becoming dk. gr.; @ 1002.[illegible]			
999.4						
			COAL - w trc. pyr.			
995.[illegible]	106					Bottom of hole

ENG FORM 1836-A

SUBSURFACE EXPLORATION
PRESSURE TEST DATA

BORING SIZE	ELEVATION TOP OF HOLE	ELEVATION TOP OF ROCK	STATIC WATER LEVEL
3 IN. (NX)	1102.0	1081.0	N/A

PUMP CAPACITY	METER TYPE	METER SERIAL NUMBER
22.9 G.P.M.	BUFFALO METER COMPANY	6547826

FIELD TEST DATA

TEST SECTION		GAUGE READING (P.S.I.)	TIME OF TEST			METER READING		TOTAL WATER Cu. Ft.)	C. F. M.
TOP DEPTH	BOTTOM DEPTH		START	END	INTERVAL (Min.-Sec.)	START OF TEST	END OF TEST		
Double Packer									
102.8	97.2	5	1034	1039	5 min.	395.71	395.71	0.00	0.00
97.8	92.2	5	1046	1051	5 min.	395.84	395.88	0.04	0.00
92.8	87.2	5	1056	1101	5 min.	396.02	396.10	0.08	0.02
87.8	82.2	5	1106	1111	5 min.	396.26	396.31	0.05	0.01
82.8	77.2	5	1117	1122	5 min.	396.81	397.20	0.39	0.08
77.8	72.2	5	1125	1130	5 min.	397.33	397.52	0.19	0.04
72.8	67.2	5	1403	1408	5 min.	427.66	427.66	0.00	0.00
67.8	62.2	5	1413	1418	5 min.	428.18	429.10	0.92	0.18
62.8	57.2	5	1421	1426	5 min.	429.22	429.23	0.01	0.00
5-12-86									
60.0	54.7	5	0854	0859	5 min.	437.40	437.46	0.06	0.01
55.0	49.7	5	0906	0911	5 min.	437.63	437.64	0.01	0.00
50.0	44.7	5	0915	0920	5 min.	437.70	437.70	0.00	0.00
45.0	39.7	5	0924	0929	5 min.	439.30	440.24	0.94	0.19
40.0	34.7	5	0934	0939	5 min.	440.80	441.70	0.90	0.18
35.0	29.7	5	0943	0948	5 min.	442.23	442.31	0.08	0.02
30.0	24.7	5	0953	0958	5 min.	442.83	442.98	0.15	0.03
25.0	19.7	5	1003	1008	5 min.	443.50	443.55	0.05	0.01
Single Packer									
60.0	106.5	5	1030	1035	5 min.	443.85	444.27	0.42	0.08

PROJECT	BORING NO.	INSPECTOR	DATE
STONEWALL JACKSON DAM	GC-1	DAVID NUGEN	5-09-86 5-12-86

ORH FORM 2142
1 DEC 68 (HED Par 1110.1.1)

Hole No. GC-2

DRILLING LOG	DIVISION O.R.D.	INSTALLATION H.E.D.	SHEET 1 OF 4 SHEETS

1. PROJECT: Stonewall Jackson Dam	10. SIZE AND TYPE OF BIT: NX Dia. Bit
2. LOCATION (Coordinates or Station): Gallery Monolith No. 2 Sta. 1+61	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL
3. DRILLING AGENCY: Pennsylvania Drilling Co.	12. MANUFACTURER'S DESIGNATION OF DRILL: Gearmac
4. HOLE NO. (As shown on drawing title and file number): GC-2	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED N/A; UNDISTURBED N/A
5. NAME OF DRILLER: Brian Adams/J. Saccani/J. McCann	14. TOTAL NUMBER CORE BOXES: 4
6. DIRECTION OF HOLE: ☐ VERTICAL ☒ INCLINED 20° u/s DEG. FROM VERT.	15. ELEVATION GROUND WATER: N/A
	16. DATE HOLE: STARTED 4-24-86; COMPLETED 4-25-86
	17. ELEVATION TOP OF HOLE: 1039.0
7. THICKNESS OF OVERBURDEN: Concrete 20.0 ft.	18. TOTAL CORE RECOVERY FOR BORING: 99.5 %
8. DEPTH DRILLED INTO ROCK: 63.0	19. SIGNATURE OF INSPECTOR: Leonard Dinger
9. TOTAL DEPTH OF HOLE: 83.0	

ELEVATION (a)	DEPTH (b)	LEGEND (c)	CLASSIFICATION OF MATERIALS (Description) (d)	% CORE RECOVERY (e)	BOX OR SAMPLE NO. (f)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) (g)
1039.0	0.0		CONCRETE			
			reinforcement steel @ 1038.2		Box 1 0.0 to 14.5 1039.0 to 1025.4	Note: Run data for Runs 1-5 not received from driller
			large s., wh. agg. @ 1034.8 to 1034.3			
	14.5				14.5	
1020.2	20					

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PROJECT: Stonewall Jackson Dam HOLE NO. GC-2

DRILLING LOG (Cont Sheet) ELEVATION TOP OF HOLE 1039.[illegible] **Hole No.** [illegible]

PROJECT Stonewall Jackson Dam | INSTALLATION H.E.D. | SHEET [illegible] OF 4 SHEETS

ELEVATION (a)	DEPTH (b)	LEGEND (c)	CLASSIFICATION OF MATERIALS (Description) (d)	% CORE RECOVERY (e)	BOX OR SAMPLE NO (f)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) (g)
1020.2	20.[illegible]		SILTSTONE - sa.; gr.; m.h.; w/h. calc. inc.			
	21				Box 2	
	22		bkn. around inc. 1018.7 to 1018.3 becoming sli. sa. @ 1018.3		14.5 to 29.0	
	23		f.g., sa. bd.; sli. x-bdd. 1017.7 to 1017.6 1017.4 to 1017.2		1025.4 to 1011.7	
	24					Pull - 6 Start 0914 End 10[illegible] Time 56 min. blew water line Drl. 36 min. Ran 5.0 Rec. 5.0 Loss 0.0 Unacc. 0.0 Depth 28.6 T. Dep. 28.6 D.W.R. Good - lt. to m. gr.
	25–28		becoming cl.; sh. @ 1012.1			
	29		becoming dk. gr. @ 1011.9		29.0	Pull - 7 Start 10[illegible] End 1125 Time 55 min. Drl. 55 min. Ran 5.0 Rec. 4.7 Loss 0.3 Unacc. [illegible] Depth 33.6 T. Dep. 33.4 D.W.R. Good - lt. to m. gr.
	30		CLAYSTONE - sl.; ve. dk. gr.; w/ sm. r. claystone se.		Box 3	
	31		becoming dk. gr. @ 1010.9		29.0 to 43.9	
	32		f.g., m.h., sa. bd. @ 1010.3 to 1010.2		1011.7 to 997.7	
1008.1	33		SILTSTONE - m.h.; m. gr.; sh.; w/ r. cl. bd. to 35.6; cl.			
	34					Pull - 8 Start [illegible] End [illegible] Time [illegible] min. Drl. [illegible] min. Ran [illegible] Rec. [illegible] Loss [illegible] Unacc. [illegible] Depth 38.[illegible] T. Dep. 38.[illegible] D.W.R. Good - lt. to m. gr.
	35		becoming ve. cl. @ 1005.9 to 1005.4			
	36		becoming less sh. @ 1004.8			
	37		sm., m.h., sli. x-bd. sandstone intbd. 1004.3 to 1003.3			
1002.9	38					
1002.5			CLAYSTONE - dk. gr.; m.s.			
	39		COAL - occ. pyr.; bkn.			Pull - [illegible] Start 14[illegible] End 144[illegible] Time [illegible] min. Drl. [illegible] min. Ran 4.[illegible] Rec. [illegible] Loss [illegible] Unacc. [illegible] Depth 4[illegible] T. Dep. 4[illegible] D.W.R. Good - m. to dk. gr. to black
	40–42					
998.1	43					
	44		SILTSTONE			

DRILLING LOG (Cont Sheet) ELEVATION TOP OF HOLE 1039.0 **Hole No.** GC-2

PROJECT: Stonewall Jackson Dam | INSTALLATION: H.E.D. | SHEET 3 OF 4 SHEETS

ELEVATION (a)	DEPTH (b)	LEGEND (c)	CLASSIFICATION OF MATERIALS (Description) (d)	% CORE RECOVERY (e)	BOX OR SAMPLE NO (f)
997.6	44.0				
991.6	50.0		SILTSTONE - m. gr.; sa.; m.h. to h.; w c.g. sa. intbd.		Box 4 43.9 to 58.6 997.7 to 983.9
988.6	53.0		SANDSTONE - lt. gr.; m.h. to h.; f.g.; sm. sl. intbd.; sl. x-bd.		
986.9	55.1		SILTSTONE - m.h.; m.g.; sl. sl.; w calc. fil. of jts.; hor. pa.		
986.0	56.0		SILTSTONE - sa.; m.h.; m. gr.		
983.1	58.9		SANDSTONE - lt. gr.; m.h., f.g.; sl. sl.; w sl. intbd.; hor. pa. @ sl. bds.		
981.3	60.7		SILTSTONE - m. to dk. gr.; m.h.		Box 5 58.6 to 73.3 983.9 to 970.1
980.0	62.0		INDURATED CLAY - s. to m.s.; m. to dk. gr.		
977.8	64.2		SILTSTONE - ve. sa.; m. gr.; m.h. to h. cl. bd. @ 978.5 to 978.3		
	68.0		CLAYSTONE - sli. sl.; m.s.; dk. gr.; hor. pa. hard nodule @ 976.2		

REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) (g)

Pull - 10

Start	1500
End	1600
Time	60 min.
Drl.	60 min.
Ran	5.0
Rec.	5.0
Loss	0.0
Unacc.	0.0
Depth	48.5
T. Dep.	48.5
D.W.R.	Good-m.gr.

End of shift; evening shift driller- B. Adams

Pull - 11

Start	1638
End	1715
Time	37 min.
Drl.	37 min.
Ran	5.1
Rec.	5.1
Loss	[illegible]
Unacc.	[illegible]
Depth	53.6
T. Dep.	53.6
D.W.R.	Good - m.gr.

Pull - 12

Start	1755
End	1836
Time	41 min.
Drl.	41 min.
Ran	5.0
Rec.	4.8
Loss	0.2
Unacc.	[illegible]
Depth	58.6
T. Dep.	58.4
D.W.R.	Good - m.gr.

Pull - 13

Start	1914
End	1957
Time	43 min.
Drl.	43 min.
Ran	5.0
Rec.	5.2
Loss	+0.2
Unacc.	0.0
Depth	63.6
T. Dep.	63.6
D.W.R.	Good - m.gr.

Pull - 14

Start	2125
End	2220
Time	55 min.
Drl.	55 min.
Ran	5.0
Rec.	4.9
Loss	0.1
Unacc.	0.0
Depth	68.6
T. Dep.	68.5
D.W.R.	Good - m.gr.

DRILLING LOG (Cont Sheet)

ELEVATION TOP OF HOLE: 1039.0 | Hole No. GC-2

PROJECT: Stonewall Jackson Dam | INSTALLATION: H.E.D. | SHEET 4 OF 4 SHEETS

ELEVATION (a)	DEPTH (b)	LEGEND (c)	CLASSIFICATION OF MATERIALS (Description) (d)	% CORE RECOVERY (e)	BOX OR SAMPLE NO. (f)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) (g)
971.0	68.0		SILTSTONE - m.s. to m.h.; cl.			Pull - 15 Start 2305 End 0005 Time 60 min. Drl. 60 min. Ran 5.0 Rec. 4.8 Loss 0.2 Unacc. 0.0 Depth 73.6 T. Dep. 73.3 D.W.R. Good - m.gr. End of shift: night shift driller-J. Saccani
970.5	69					
	70		CLAYSTONE - m.s. to m.h.; dk. gr.; hor. pa.; w/occ. sm. limestone nod.			
	73		becoming slk. @ 969.9			
	75		becoming gr. to r. 968.2 to 966.4		Box 6 73.3 to 83.0 970.1 to 961.0	Pull - 16 Start 0615 End 0655 Time 40 min. Blew water line Drl. 5 min. Ran 4.4 Rec. 4.4 Loss 0.0 Unacc. 0.0 Depth 77.4 T. Dep. 77.4 D.W.R. Good - m.gr. to r. to m. gr.
	76		slk. pa. 968.0 to 966.3			
966.1	77					
	78		SILTSTONE - m.h.; c.g.; m. gr.; sli. cl.			
965.2						
	79		CLAYSTONE - sli. sl. to 80.6; m. gr.			Pull - 17 Start 0715 End 0810 Time 55 min. Drl. 55 min. Ran 5.0 Rec. 5.6 Loss +0.6 Unacc. 0.0 Depth 83.0 T. Dep. 83.0 D.W.R. Good - m.gr. to r. br.; to m.gr.
	80		red			
963.8			becoming ve. sl. @ 963.3			
	81					
	82					
961.0	83					Bottom of hole 83.0
	84					

ENG FORM 1836-A JUN 67 | PROJECT: Stonewall Jackson Dam | HOLE NO. GC-2

SUBSURFACE EXPLORATION
PRESSURE TEST DATA

BORING SIZE	ELEVATION TOP OF HOLE	ELEVATION TOP OF ROCK	STATIC WATER LEVEL
3 IN. (NX)	1039.0	1019.0	N/A

PUMP CAPACITY	METER TYPE	METER SERIAL NUMBER
22.9 G.P.M.	BUFFALO METER COMPANY	6547826

FIELD TEST DATA

TEST SECTION		GAUGE READING (P.S.I.)	TIME OF TEST			METER READING		TOTAL WATER Cu. Ft.)	C. F. M.
TOP DEPTH	BOTTOM DEPTH		START	END	INTERVAL (Min.-Sec.)	START OF TEST	END OF TEST		
Double Packer									
79.6	74.0	25	0958	1003	5 min.	567.60	567.71	0.11	0.02
74.6	69.0	25	1012	1017	5 min.	568.41	568.41	0.00	0.00
69.6	64.0	25	1020	1025	5 min.	568.45	568.72	0.27	0.05
64.6	59.0	25	1036	1041	5 min.	568.75	568.76	0.01	0.00
59.6	54.0	25	1044	1049	5 min.	568.79	568.79	0.00	0.00
54.6	49.0	25	1053	1058	5 min.	568.84	568.88	0.04	0.01
49.6	44.0	25	1103	1108	5 min.	568.90	568.97	0.07	0.01
44.6	39.0	25	1112	1117	5 min.	569.04	569.19	0.15	0.03
39.6	34.0	25	1122	1127	5 min.	569.28	569.65	0.37	0.07
34.6	29.0	25	1130	1135	5 min.	569.75	570.13	0.38	0.08
29.6	24.0	25	1139	1144	5 min.	570.25	570.71	0.46	0.09
24.6	19.0	25	1149	1154	5 min.	570.90	571.60	0.70	0.14

PROJECT	BORING NO.	INSPECTOR	DATE
STONEWALL JACKSON DAM	GC-2	DAVID NUGEN	4-25-86

ORH FORM 2142 (HED Pam 1110.1.1)

Hole No.

DRILLING LOG	DIVISION ..R.D.	INSTALLATION R.D.	SHEET OF SHEETS

1. PROJECT: Stonewall Jackson Dam
2. LOCATION (Coordinates or Station): Monolith No. ... Sta. 4-5...
3. DRILLING AGENCY: Pennsylvania Drilling Co.
4. HOLE NO. (As shown on drawing title and file number): ...
5. NAME OF DRILLER:
6. DIRECTION OF HOLE: [x] VERTICAL [ ] INCLINED ____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN: Concrete 9.7
8. DEPTH DRILLED INTO ROCK: 52.5
9. TOTAL DEPTH OF HOLE: 66.2
10. SIZE AND TYPE OF BIT: NX ...
11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL
12. MANUFACTURER'S DESIGNATION OF DRILL: Searmac
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED / UNDISTURBED
14. TOTAL NUMBER CORE BOXES
15. ELEVATION GROUND WATER
16. DATE HOLE: STARTED 5-15-86 COMPLETED 5-15-86
17. ELEVATION TOP OF HOLE: 49...
18. TOTAL CORE RECOVERY FOR BORING: 94.? %
19. SIGNATURE OF INSPECTOR: [signature]

ELEVATION (a)	DEPTH (b)	LEGEND (c)	CLASSIFICATION OF MATERIALS (Description) (d)	% CORE RECOVERY (e)	BOX OR SAMPLE NO. (f)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) (g)
484.?			0.0 to 9.7 CONCRETE		Box 1	
			SANDSTONE - lt. gr.; m.h.; sl.; f.g.		... to 14.1	Note: Run data not received from driller
					993.7 to 979.6	
			CLAYSTONE - dk. to m. gr.; m.s.; slk. pa.			
			SANDSTONE - lt. gr.; m.h.; ...; sl. x-bd.			
			CLAYSTONE - dk. to m. gr.; m.s.; slk. pa.			
			SILTSTONE - m. gr. to br.; m.h. to m.s.; cl.; w/h. br. nod.		Box 2	
			cl. bd. @ 977.? to 977.?		14.1 to 27.9	
			vert. frac. @ 976.4 to 975.?		979.6 to 965.8	
			0.?' core loss accum. between ... & ...			
			sandy bd. @ 971.?			
			INDURATED CLAY - gr. to ...; m.s.; sl. ... bkn.			
			...			
			...STONE - ... ... areas			

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE (TRANSLUCENT) PROJECT HOLE NO.

DRILLING LOG (Cont Sheet) | ELEVATION TOP OF HOLE 993.7 | Hole No. [illegible]

PROJECT: Stonewall Jackson Dam | INSTALLATION: H.E.L. | SHEET [illegible] OF [illegible] SHEETS

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
	30		overdrilled 30.2 to 30.6		Box 3	
	31				27.4 to 42.3	
	32		m.h.; f.g.; x-bd. sa. bd. 962.1 to 961.5; becoming ve. cl. @ 961.5 also sh.; becoming dk. gr. to r. @ 960.		965.8 to 951.7	
96[illegible]	33					
	34		CLAYSTONE - gr. to r.; sn.; m.s.			
	35					
	36					
9[illegible].4	37					
	38		LIMESTONE - gr. to br.; m.h. to h.			
	39		vert. frac. 955. to 954.7			
	40					
	41					
	42					
950.6	43		CLAYSTONE - dk. to lt. gr.; m.s. to m.h.; sl.; bkn.; occ. slk.; occ. cl. se.		Box 4	
	44				42.3 to 56.6	
	45		0.3' core loss 45.2 to 45.5		951.7 to 937.1	
	46					
	47					
	48					
	49					
	50		0.6' core loss 50.1 to 50.7			
	51					
	52					
	53					

DRILLING LOG (Cont Sheet)	ELEVATION TOP OF HOLE 993.7		Hole No.
PROJECT Stonewall Jackson Dam	INSTALLATION H.E.D.		SHEET OF SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
940.7	53.0					
	54		occ. pyrite cst. below 940.7			
939.0						
938.4	55		COAL - low grade			
	56		CLAYSTONE - m. gr.; s. to m.s.; hi, bkn. & crumbly w cl. se.; occ. sm. pyr. cst.			
	57				Box 5	
935.1	58				56.6 to 62.2	
	59		SILTSTONE - m. gr.; m.h.; cl.; sli. sh.; w/occ. sm. cl. se. @ 62.2		937.1 to 931.5	
	60					
	61					
931.5	62		0.8' core loss 61.4 to 62.2 (clay seam cl. se. @ 931.5			Bottom of Hole
	63					

ENG FORM 1836-A JUN 67

PROJECT Stonewall Jackson Dam HOLE NO.

SUBSURFACE EXPLORATION
PRESSURE TEST DATA

BORING SIZE	ELEVATION TOP OF HOLE	ELEVATION TOP OF ROCK	STATIC WATER LEVEL
3 IN. (NX)	993.7	984.0	N/A

PUMP CAPACITY	METER TYPE	METER SERIAL NUMBER
22.9 G.P.M.	BUFFALO METER COMPANY	6547826

FIELD TEST DATA

TEST SECTION		GAUGE READING (P.S.I.)	TIME OF TEST			METER READING		TOTAL WATER Cu. Ft.)	C. F. M.
TOP DEPTH	BOTTOM DEPTH		START	END	INTERVAL (Min.-Sec.)	START OF TEST	END OF TEST		
Single Packer									
51.5	62.5	40	0340	0345	5 min.	478.13	478.38	0.25	0.05
Double Packer									
52.0	47.2	40	0505	0510	5 min.	480.27	480.34	0.07	0.01
47.0	42.2	40	0520	0525	5 min.	480.67	480.82	0.15	0.03
42.0	37.2	40	0530	0535	5 min.	480.86	480.86	0.00	0.00
37.0	32.2	40	0540	0545	5 min.	481.50	481.50	0.00	0.00
32.0	27.2	40	0550	0555	5 min.	481.55	481.73	0.18	0.03
27.0	22.2	40	0600	0605	5 min.	481.91	482.69	0.78	0.16
22.0	17.2	40	0610	0615	5 min.	482.74	482.84	0.10	0.02
17.0	12.2	40	0620	0625	5 min.	482.87	482.91	0.04	0.01
12.0	7.2	40	0630	0635	5 min.	482.92	482.92	0.00	0.00

PROJECT	BORING NO.	INSPECTOR	DATE
STONEWALL JACKSON DAM	GC-3	DAVID NUGEN	5-15-86

ORH FORM 2142 (HED Pam 1110.1.1)
1 DEC 68

Hole No. GC-4

DRILLING LOG	DIVISION O.R.D.	INSTALLATION H.E.D.	SHEET 1 OF 4 SHEETS

1. PROJECT Stonewall Jackson Dam	10. SIZE AND TYPE OF BIT NX Dia. Bit
2. LOCATION (Coordinates or Station) Sta. 5+70	11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL
3. DRILLING AGENCY Pennsylvania Drilling Co.	12. MANUFACTURER'S DESIGNATION OF DRILL Gearmatic
4. HOLE NO. (As shown on drawing title and file number) GC-4	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN — DISTURBED --- UNDISTURBED ---
5. NAME OF DRILLER	14. TOTAL NUMBER CORE BOXES 6
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER
	16. DATE HOLE — STARTED 5-13-86 — COMPLETED 5-13-86
7. THICKNESS OF OVERBURDEN Concrete 25.9	17. ELEVATION TOP OF HOLE 1007.5
8. DEPTH DRILLED INTO ROCK 51.0	18. TOTAL CORE RECOVERY FOR BORING 91.0 %
9. TOTAL DEPTH OF HOLE 76.9	19. SIGNATURE OF INSPECTOR David [signature]

ELEVATION (a)	DEPTH (b)	LEGEND (c)	CLASSIFICATION OF MATERIALS (Description) (d)	% CORE RECOVERY (e)	BOX OR SAMPLE NO. (f)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) (g)
1007.5	0.0		CONCRETE			
	1				Box 1 0.0 to 14.7 1007.5 to 992.8	Note: Run data not received from driller
	10		Mech. bkn. @ 997.0			
	20					

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT Stonewall Jackson Dam | HOLE NO. GC-4

DRILLING LOG (Cont Sheet) ELEVATION TOP OF HOLE [illegible] **Hole No.** GC-4

PROJECT: Stonewall Jackson Dam | INSTALLATION: H.L.D. | SHEET [illegible] OF 4 SHEETS

ELEVATION (a)	DEPTH (b)	LEGEND (c)	CLASSIFICATION OF MATERIALS (Description) (d)	% CORE RECOVERY (e)	BOX OR SAMPLE NO. (f)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) (g)
98[illegible]	2[illegible]					
	21				Box .	
	22				14.[illegible] to 29.[illegible]	
	23				992.8 to 978.[illegible]	
	24					
	25					
981.6	26		SILTSTONE - gr.; m.s. to m.h.; ve. cl.			
	27		h. br. nod. @ 981.3			
			bkn.			
			spun core @ 2[illegible].			
	28		alt. m.s., cl. bd. & h. to m.h., sa. bd. @ 979.[illegible] to 978.[illegible]			
978.[illegible]	29					
	30		CLAYSTONE - dk. to m. gr.; m.s.; sli. sh.			
	31		becoming sli. sl. @ 976.2			
	32					
	33					
	34					
	35					
971.8	36		INDURATED CLAY - lt. gr. m.s.		Box [illegible]	
970.6	37		SILTSTONE - m.h.; m.gr.; filled diag. frac.		29.[illegible] to 43.[illegible]	
969.9	38		INDURATED CLAY - m. gr. to r. m.s. to s.; hi. bkn. & crumbly areas		978.[illegible] to 963.9	
	39					
	40		sm. s. cl. se. 968.6 to 967.3			
	41					
	42					
	43					
	44					

ENG FORM 1836-A JUN 67 | PROJECT Stonewall Jackson Dam | HOLE NO. GC-4

DRILLING LOG (Cont Sheet) ELEVATION TOP OF HOLE 1007.5 **Hole No.** SC-4

PROJECT Stonewall Jackson Dam INSTALLATION H.E.D. SHEET 3 OF 4 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
963.5	44.0					
	45		SILTSTONE - m. gr.; m.h.; limy sa. bd. @ 962.7 to 962.3		Box 4	
	46		0.75' lost core 46.1 to 46.85		43.6 to 58.2	
959.9	47		becoming r. & cl. @ 960.6		963.9 to 949.3	
	48		CLAYSTONE - gr. to r.; m.s. to s.; slk. pa.; hi. bkn.			
	49					
	50					
	51					
	52					
	53					
952.5	54					
	55		LIMESTONE - sli. cl.; br. to gr.; m.h. to h.			
	56					
	57					
	58					
	59					
	60					
	61				Box 5	
945.2	62				58.2 to 72.4	
	63		CLAYSTONE - m.h. to s.; dk. gr. to br.; hi. bkn.; w/nod. & cl. se.		949.3 to 935.1	
	64					
	65					
	66		4.5 ft. core loss between 62.3 & 70.4 945.2 to 937.1			
	67					
	68					

DRILLING LOG (Cont Sheet) ELEVATION TOP OF HOLE

Hole No [illegible]

PROJECT Stonewall Jackson Dam | INSTALLATION H.E.D. | SHEET 4 OF 4 SHEETS

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
935.2			SILTSTONE - dk. gr., m.h. to h.; w/th. br. sil. nods.; irr. pa.			
934.4	73		COAL - low grade			
	74		CLAYSTONE - m.s.; dk. gr.; sl.; slk. pa.; occ. fos. w/tr. pyr.		Box 6 72.4 to 76.9 935.1 to 930.6	
						Bottom of hole

ENG FORM 1836-A JUN 67

PROJECT Stonewall Jackson Dam HOLE NO GC-4

SUBSURFACE EXPLORATION
PRESSURE TEST DATA

BORING SIZE	ELEVATION TOP OF HOLE	ELEVATION TOP OF ROCK	STATIC WATER LEVEL
3 IN. (NX)	1007.5	981.6	N/A

PUMP CAPACITY	METER TYPE	METER SERIAL NUMBER
22.9 G.P.M.	BUFFALO METER COMPANY	6547826

FIELD TEST DATA

TEST SECTION		GAUGE READING (P.S.I.)	TIME OF TEST			METER READING		TOTAL WATER Cu. Ft.)	C. F. M.
TOP DEPTH	BOTTOM DEPTH		START	END	INTERVAL (Min.-Sec.)	START OF TEST	END OF TEST		
Single Packer									
72.7	77.1	40	1016	1021	5 min.	445.52	445.52	0.00	0.00
60.4	77.1	40	1042	1047	5 min.	446.55	447.13	0.58	0.12
55.4	77.1	40	1053	1058	5 min.	448.50	451.64	3.14	0.63
Double Packer									
58.0	52.8	40	1140	1145	5 min.	452.80	455.36	2.56	0.51
53.0	47.8	40	1152	1157	5 min.	455.58	455.91	0.33	0.07
48.0	42.8	40	1238	1243	5 min.	456.50	458.28	1.78	0.36
43.0	37.8	40	1248	1253	5 min.	458.70	459.80	1.10	0.22
38.0	32.8	40	1258	1303	5 min.	459.95	460.35	0.40	0.08
33.0	27.8	40	1310	1315	5 min.	460.50	460.95	0.45	0.09
28.0	22.8	40	1320	1325	5 min.	461.20	461.99	0.79	0.16

PROJECT	BORING NO.	INSPECTOR	DATE
STONEWALL JACKSON DAM	GC-4	DAVID NUGEN	5-14-86

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Hole No. [illegible]

DRILLING LOG

DIVISION	O.R.D.
INSTALLATION	H.E.D.
SHEET	OF SHEETS
1. PROJECT	Stonewall Jackson Dam
2. LOCATION (Coordinates or Station)	Monolith No. 13 Sta. 6+17
3. DRILLING AGENCY	Pennsylvania Drilling Co.
4. HOLE NO. (As shown on drawing title and file number)	SC-5
5. NAME OF DRILLER	
6. DIRECTION OF HOLE	[x] VERTICAL [ ] INCLINED ____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN	Concrete 35.2
8. DEPTH DRILLED INTO ROCK	52.2
9. TOTAL DEPTH OF HOLE	87.4
10. SIZE AND TYPE OF BIT	NX Dia. Bit
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	MSL
12. MANUFACTURER'S DESIGNATION OF DRILL	Gearmac
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN	DISTURBED --- UNDISTURBED ---
14. TOTAL NUMBER CORE BOXES	
15. ELEVATION GROUND WATER	
16. DATE HOLE	STARTED 5-12-86 COMPLETED 5-12-86
17. ELEVATION TOP OF HOLE	1032.5
18. TOTAL CORE RECOVERY FOR BORING	99.3 %
19. SIGNATURE OF INSPECTOR	[signature]

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
1032.5	0.0		CONCRETE		Box 1 0.0 to 14.1	NX Core bbl. 5.8' Note: Run data not received from driller.
	5					
	10					
	15				Box 2 14.1 to 28.8	
	20					
	25		filled, angled drill hole 24.8 to 25.5			
	30				Box 3 28.8 to 43.1 1003.7 to 989.4	
996.8	35		Conc. rock contact - good 35.7 Elev. 996.8			
	36		SILTSTONE - m. gr.; m.h.; sa. mech. bkn. 35.9 m.h.; f.g. sandstone bd. 995.5 to 995.1			
	37					
	38					
	39		sm. alt.; x-bd. ss. bd. & sltst. bd. 995.1 to 991.5			
	40		diag., fil. frac.			
	41					
	42					
989.7	43		CLAYSTONE - m. gr.; m.s.; sl.			
987.8	44				Box 4 43.1 to 57.7 989.4 to 974.8	
	45		SANDSTONE - lt. to m. gr.; m.h. to h.; f.g. diag. frac. 987.2 to 987.1			
	46					
	47					
	48					

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PROJECT Stonewall Jackson Dam | HOLE NO. SC-5

DRILLING LOG (Cont Sheet)

ELEVATION TOP OF HOLE: 1032.5 | **Hole No.** GC-5

PROJECT: Stonewall Jackson Dam | INSTALLATION: H.E.D. | SHEET [illegible] OF 3 SHEETS

ELEVATION (a)	DEPTH (b)	LEGEND (c)	CLASSIFICATION OF MATERIALS (Description) (d)	% CORE RECOVERY (e)	BOX OR SAMPLE NO. (f)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) (g)
984.5	48.0		sl. st. ba.; dk. to m. gr.; m.h. 984.[illegible] to 983.2			
981.7			CLAYSTONE - dk. to m. gr.; m.s. to m.h.; sl.; slk. pa.; w/occ. h. br. nod.			
979.3	53		SILTSTONE - mg. gr.; m.h.			
977.9			CLAYSTONE - dk. to m. gr.; m.s.; sli. sh. h. sil. nod. @ 977.2 h. sil. nod. @ 975.5			
974.8			SILTSTONE - m. gr.; m.h.; cl.; w/occ. h. sil. nod.		Box 5 57.7 to 71.1 974.8 to 961.4	
971.7			CLAYSTONE - m. gr.; m.s.; slk. pa. 0.2' core loss 61.8 to 62.0			
968.7			INDURATED CLAY - gr. to r.; m.s. to s. bkn. 0.2' core loss 65.7 to 65.9			
965.5	67		SILTSTONE - m. to lt. gr.; m.h.; sa.; sli. mic.; irr. pa.			
963.1			CLAYSTONE - r. to gr.; m.s.; sli. sh. to 71.1 0.2' core loss 70.5 to 70.7			

Depth scale: 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72

DRILLING LOG (Cont Sheet)	ELEVATION TOP OF HOLE 1032.5	Hole No. GC-5
PROJECT Stonewall Jackson Dam	INSTALLATION H.E.L	SHEET OF SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	73		r. cl. se. @ 959.5 to 959.3		Box 6	
	74				71.1 to 86.1	
	75				961.4 to 946.3	
	76					
	77		slk. pa @ 956.3 to 953.6			
	78					
953.5	79		LIMESTONE - lt. br. to lt. gr.; m.h. to h.; occ. sl. bd.			
	80–85					
946.5	86		CLAYSTONE - m. gr.; m.h.; sl.; bkn.		Box 7	
	87				86.1 to 87.4	Bottom of hole
	88				946.3 to 945.1	
	89					

ENG FORM 1836-A JUN 67

PROJECT Stonewall Jackson Dam HOLE NO. GC-5

SUBSURFACE EXPLORATION
PRESSURE TEST DATA

BORING SIZE	ELEVATION TOP OF HOLE	ELEVATION TOP OF ROCK	STATIC WATER LEVEL
3 IN. (NX)	1032.5	996.8	N/A

PUMP CAPACITY	METER TYPE	METER SERIAL NUMBER
22.9 G.P.M.	BUFFALO METER COMPANY	6547826

FIELD TEST DATA

TEST SECTION		GAUGE READING (P.S.I.)	TIME OF TEST			METER READING		TOTAL WATER (Cu. Ft.)	C. F. M.
TOP DEPTH	BOTTOM DEPTH		START	END	INTERVAL (Min.-Sec.)	START OF TEST	END OF TEST		
Single Packer									
70.0	87.8	25	1440	1445	5 min.	464.00	467.45	3.45	0.69
80.0	87.8	25	1454	1459	5 min.	468.50	471.37	2.87	0.57
Double Packer									
83.7	78.5	25	1550	1555	5 min.	472.50	475.72	3.22	0.64
5-15-86									
78.7	73.5	25	1250	1255	5 min.	476.13	476.20	0.07	0.01
73.7	68.5	25	1305	1310	5 min.	476.28	476.33	0.05	0.01
68.7	63.5	25	1315	1320	5 min.	476.42	476.72	0.30	0.06
63.7	58.5	25	1324	1329	5 min.	476.73	476.74	0.01	0.00
58.7	53.5	25	1335	1340	5 min.	476.86	476.87	0.01	0.00
53.7	48.5	25	1344	1349	5 min.	476.90	476.90	0.00	0.00
48.7	43.5	25	1359	1404	5 min.	477.04	477.05	0.01	0.00
43.7	38.5	25	1408	1413	5 min.	477.42	477.44	0.02	0.00
38.7	33.5	25	1417	1422	5 min.	477.48	477.48	0.00	0.00

PROJECT	BORING NO.	INSPECTOR	DATE
STONEWALL JACKSON DAM	GC-5	DAVID NUGEN	5-14-86 5-15-86

ORH FORM 2142 (HED Pam 1110.1.1)
1 DEC 68

Hole No. SC-6

DRILLING LOG	DIVISION S.R.D.	INSTALLATION H.L.D.	SHEET 1 OF 1 SHEETS

1. PROJECT: Stonewall Jackson Dam	10. SIZE AND TYPE OF BIT: NX Dia. Bit
2. LOCATION (Coordinates or Station): Sta 1+96.75	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL
3. DRILLING AGENCY: Pennsylvania Drilling Co.	12. MANUFACTURER'S DESIGNATION OF DRILL: Gearmatic
4. HOLE NO. (As shown on drawing title and file number): SC-6	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED --- UNDISTURBED ---
5. NAME OF DRILLER: Jim McCann	14. TOTAL NUMBER CORE BOXES: 1
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER: ---
7. THICKNESS OF OVERBURDEN: Concrete 9.4	16. DATE HOLE: STARTED 5-27-86 COMPLETED 5-27-86
8. DEPTH DRILLED INTO ROCK: 1.1	17. ELEVATION TOP OF HOLE: 1005.0
9. TOTAL DEPTH OF HOLE: 10.5	18. TOTAL CORE RECOVERY FOR BORING: 100 %
	19. SIGNATURE OF INSPECTOR: [signature]

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
1005.0	0.0		CONCRETE			Drill through concrete (0.0 - 9.4) 1 ft. into rock checking concrete/rock contact Drill time: 54 min.
995.6	9.4		Concrete/rock contact			
			good, tight			Bottom of hole
						10.5 el. 494.5

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE (TRANSLUCENT)

PROJECT: Stonewall Jackson Dam HOLE NO. SC-6

SUBSURFACE EXPLORATION
PRESSURE TEST DATA

BORING SIZE	ELEVATION TOP OF HOLE	ELEVATION TOP OF ROCK	STATIC WATER LEVEL
3 IN. (NX)	1005.0	995.7	N/A

PUMP CAPACITY	METER TYPE	METER SERIAL NUMBER
22.9 G.P.M.	BUFFALO METER COMPANY	6547826

FIELD TEST DATA

TEST SECTION		GAUGE READING (P.S.I.)	TIME OF TEST			METER READING		TOTAL WATER Cu. Ft.)	C. F. M.
TOP DEPTH	BOTTOM DEPTH		START	END	INTERVAL (Min.-Sec.)	START OF TEST	END OF TEST		
Single Packer									
0.0	10.5	40	0859	0904	5 min.	668.85	669.63	0.78	0.15

SLIGHT CONNECTION TO DRAIN HOLES
NO. 8 & 9

PROJECT	BORING NO.	INSPECTOR	DATE
STONEWALL JACKSON DAM	GC-6	DAVID NUGEN	5-28-84

ORH FORM 2142 (HED Par 1110.1.1)
1 DEC 68

SUBSURFACE EXPLORATION
PRESSURE TEST DATA

BORING SIZE	ELEVATION TOP OF HOLE	ELEVATION TOP OF ROCK	STATIC WATER LEVEL
3 IN. (NX)	1005.0	995.7	N/A

PUMP CAPACITY	METER TYPE	METER SERIAL NUMBER
22.9 G.P.M.	BUFFALO METER COMPANY	6547826

FIELD TEST DATA

TEST SECTION		GAUGE READING (P.S.I.)	TIME OF TEST			METER READING		TOTAL WATER Cu. Ft.)	C. F. M.
TOP DEPTH	BOTTOM DEPTH		START	END	INTERVAL (Min.-Sec.)	START OF TEST	END OF TEST		
Single Packer									
0.00	10.5	40	0848	0853	5 min.	660.00	667.75	7.75	1.55

CONNECTED TO DRAIN HOLES NOS.
8, 9, 10 AND EXPLORATORY HOLE
GC-6

DATE 5-28-86

ORM ... 21-2

Hole No.

DRILLING LOG	DIVISION	INSTALLATION	SHEET OF SHEETS

1 PROJECT: Stonewall Jackson Dam
2 LOCATION (Coordinates or Station): Sta. 2+[illegible]
3 DRILLING AGENCY: Pennsylvania Drilling Co.
4 HOLE NO. (As shown on drawing title and file number): [illegible]
5 NAME OF DRILLER: Jim McCann
6 DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ______ DEG. FROM VERT.
7 THICKNESS OF OVERBURDEN: Concrete 9.4
8 DEPTH DRILLED INTO ROCK: 1.1
9 TOTAL DEPTH OF HOLE: 10.5
10 SIZE AND TYPE OF BIT: NX [illegible]
11 DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL
12 MANUFACTURER'S DESIGNATION OF DRILL: Searman
13 TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED --- UNDISTURBED ---
14 TOTAL NUMBER CORE BOXES:
15 ELEVATION GROUND WATER: ---
16 DATE HOLE: STARTED 5-27-8[illegible] COMPLETED [illegible]
17 ELEVATION TOP OF HOLE: [illegible]
18 TOTAL CORE RECOVERY FOR BORING: [illegible] %
19 SIGNATURE OF INSPECTOR: [illegible]

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
1005.[illegible]	0.0		CONCRETE			Drill through concrete (0.0 to 9.4) 1 ft. into rock checking concrete rock contact. Drill time: 54 min.
995.6	9.4		Concrete rock contact			
			Good, tight			Bottom of hole 10.5 el. 994.5

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE (TRANSLUCENT)

PROJECT: Stonewall Jackson Dam HOLE NO. [illegible]

Hole No. 50-A

DRILLING LOG	DIVISION	INSTALLATION	SHEET 1 OF 4 SHEETS
	O.R.D.	O.R.D.	

1. PROJECT: Stonewall Jackson Dam	10. SIZE AND TYPE OF BIT: NX Dia. Bit
2. LOCATION (Coordinates or Station): Sta. 7+51.50 45' Downstream	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL
3. DRILLING AGENCY: Pennsylvania Drilling Co.	12. MANUFACTURER'S DESIGNATION OF DRILL: Mobile 81
4. HOLE NO. (As shown on drawing title and file number): 50-A	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED N.A. UNDISTURBED N.A.
5. NAME OF DRILLER: Jim Lang	14. TOTAL NUMBER CORE BOXES: 5
6. DIRECTION OF HOLE: [X] VERTICAL [ ] INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER
	16. DATE HOLE: STARTED 5-30-86 COMPLETED 5-30-86
7. THICKNESS OF OVERBURDEN: 20.0 ft. (1082.0)	17. ELEVATION TOP OF HOLE: 1102.0
8. DEPTH DRILLED INTO ROCK: 72.5 ft.	18. TOTAL CORE RECOVERY FOR BORING: 98.6 %
9. TOTAL DEPTH OF HOLE: 92.5 ft. (1009.5)	19. SIGNATURE OF INSPECTOR: [signature]

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
1082.0	20.0		SILTSTONE - sli. sa.; gr.; m.s.; hor. pa.		Box 1	Auger 20.0 ft. to rock. Reset auger 5.4 ft. after first run; auger depth 25.4 ft.
	21		highly wd. & sta. 1081 to 1080.4		20.0 to 35.1	NX core bbl. 11.1 ft. 0.0 to 20.0 Imp. fill
	22				1082.0 to 1066.9	
	23		m. sa. 1080.4 to 1077.1			Pull - 1
	24					Start 1020; End 1026; Time 6 min.; Drl. 6 min.; Ran 6.2; Rec. 6.2; Loss 0.0; Unacc. 0.0; Depth 26.2 soft; T. Dep. 22.6; D. W.R. Good
	25		m. sand below 25. becoming clayey 1077.1			
	26		red 25.4 to 26.2			
1075.4			lost core 26.2 to 26.6			
	27		CLAYSTONE - m.g.; m.s.			
1074.2						
	28		SILTSTONE - lt. to m. gr.; m.h.; w/f. g. sa.			
	29		sta. frac. @ 1072.8			Pull - 2
			sli. x-bd. 1072.7 to 1072.2			Start 1050; End 1101; Time 11 min.; Drl. 11 min.; Ran 2.8; Rec. 2.4; Loss 0.4; Unacc. 0.4; Depth 29.0; T. Dep. 25.0; D. W.R. Good - grav
	30		not sandy 1072.2 to 1071.1			
	31		sm., m.s., dk. gr. sl. len. 1071.1 to 1070.5			
	32					
	33					
1067.6	34					Pull - 3
	35		CLAYSTONE - r. to gr.; m.s. to s.; bkn. w/slk. pa.			Start 1106; End 1124; Time 18 min.; Drl. 18 min.; Ran [illegible]; Rec. [illegible]; Loss [illegible]; Unacc. [illegible]; Depth [illegible]; T. Dep. [illegible]; D. W.R. Good; gray - [illegible]
	36					
			gray 1065.4 to [illegible]			
	37					
	38					
	39					
	40					

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE (TRANSLUCENT)

PROJECT: Stonewall Jackson Dam HOLE NO. 50-A

DRILLING LOG (Cont Sheet) ELEVATION TOP OF HOLE 1102.[illegible] **Hole No.** [illegible]

PROJECT: Stonewall Jackson Dam | INSTALLATION: H.E.D. | SHEET [illegible] OF 4 SHEETS

ELEVATION (a)	DEPTH (b)	LEGEND (c)	CLASSIFICATION OF MATERIALS (Description) (d)	% CORE RECOVERY (e)	BOX OR SAMPLE NO (f)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) (g)
1102.0	40.0					Pull - 4
	41		h. calc. inc. 1061.3 to 1059.8		Box 2	Start 1141
1060.6						End 1220
			SILTSTONE - lt. gr.; m.s.; cl. to 43.5: elev. 1056.5		35.1	Time 38 min.
	42				to	Drl. 35 min.
					49.8	Ran 10.0
						Rec. 9.5
	43				1066.9	Loss 0.5
			becoming sandy w/occ. h. calc. inc. 1058.5		to	Unacc. 0.1
					1052.2	Depth 49.0
	44					T. Dep. 48.3
1057.5						D.W.R. Good r.-br.-gr.
	45		SANDSTONE - f.g.; lt. gr.; m.h.			
	46		mech. bkn. 46.2			
			filled drill hole			
	47					
1054.3						
	48		CLAYSTONE - m.s.; g. to r.; sl.			
			0.1 ft. lost core between 47.9 & 48.3			
	49		becoming less silty w/occ. slk. below 48.3: 1053.7			
	50					Pull - 5
						Start 1240
						End 1305
					Box 3	Time 25 min.
	51					Drl. 25 min.
					49.8	Ran 10.0
					to	Rec. 10.6
	52				64.9	Loss +0.6
						Unacc. 0.0
					1052.2	Depth 59.0
	53				to	T. Dep. 58.9
					1037.1	D.W.R. Good r.-gr.
	54		crumbly 53.7 to 55.5 1048.5 to 1046.5			
	55					
	56		becoming silty @ 1046.0			
	57					
	58		h. calc. inc. & r. to gr. mot. 1045.0 to 1043.7			
1043.1	59					
			SILTSTONE - r. to gr.; m.s. to m.h.; cl.			Pull - 6
	60					Start 1320
						End 1343
						Time 23 min.
	61		mech. bkn. @ 61.1			Drl. 23 min.
						Ran 10.0
						Rec. 8.8
	62					Loss 1.2
						Unacc. 0.2
						Depth 69.0
	63					T. Dep. 67.9
						D.W.R. Good - gray
	64		3 diagonal fractures 1038.5 to 1037.9			End of shift

DRILLING LOG (Cont Sheet) ELEVATION OF OF HOLE 11__ Hole No. GC-6

PROJECT Stonewall Jackson Dam | INSTALLATION H.E.D. | SHEET 3 OF 4 SHEETS

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
			calc. inc. 1 ... to 1 ...			
1036.1	65					
	66		SANDSTONE - f.g.; m.h.; lt. gr.; ver. fract. sta. to 69.4; sta. hor. pa.		Box 4	
	67		0.2 ft. core loss accum. throughout run.		64.9 to 79.9	
1034.1	68		SILTSTONE - m. gr.; m.h. to m.s.; w/occ. h. inc.; cl. to 68.5 elev. 1033.5		1037.1 to 1022.1	
	69–70					Pull - 7 Start 1440 End 1524 Time 44 min. Drl. 44 min. Ran 10.0 Rec. 10.8 Loss +0.8 Unacc. 0.3 Depth 79.0 T. Dep. 79.0 D.W.R. Good
	71		dk. gr.; cl. 1030.9 to 1030.2			
	72–73		bkn. sta. 1030.0 to 1028.7			
	74–78					
	79		slk. w/sm. ls. nod. below 1023.0			
	80–81		sli. cl. 1023.0 to 1021.0 becoming harder @ 1021.0		Box 5 79.9 to 92.5	Pull - 8 Start 1600 End 1622 Time 22 min. Drl. 22 min. Ran 10.0 Rec. 9.9 Loss 0.1 Unacc. 0.0
1019.7	82					
	83		SANDSTONE - m.h. to h.; lt. gr.; f. to m.g.; incr. g. size toward bottom of unit		1022.1 to 1009.5	Depth 89.0 T. Dep. 88.9 D.W.R. Good
	84		mech. bkn. 83.7 1018.3			
	85–88					

ENG FORM 1836-A JUN 67 | PROJECT Stonewall Jackson Dam | HOLE NO. GC-6

DRILLING LOG (Cont Sheet) ELEVATION TOP OF HOLE 1102. **Hole No.** SJ-8

PROJECT Stonewall Jackson Dam INSTALLATION H.L.D. SHEET 4 OF 4 SHEETS

ELEVATION a	DEPTH 88. b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			Claystone bd. m.s. 1 14.			Pull - 9
	89					Start 1700 End 1710 Time 10 min. Drl. 10 min. Ran 3.5 Rec. 3.5 Loss 0.0 Unacc. 0.1 Dep. 92.5 T. Dep. 92.5
	90					
	91		mech. bkn. 91.2' 1010.8			
	92		0.1 ft. lost core accum. throughout run			Bottom of hole 92.5 Elev. 1009.5
	93					
	94					
	95					

ENG FORM 1836-A JUN 67 PROJECT Stonewall Jackson Dam HOLE NO. SJ-8

SUBSURFACE EXPLORATION
PRESSURE TEST DATA

BORING SIZE	ELEVATION TOP OF HOLE	ELEVATION TOP OF ROCK	STATIC WATER LEVEL
3 IN. (NX)	1102.0	1082.0	N/A

PUMP CAPACITY	METER TYPE	METER SERIAL NUMBER
22.9 G.P.M.	BUFFALO METER COMPANY	6547826

FIELD TEST DATA

TEST SECTION		GAUGE READING (P.S.I.)	TIME OF TEST			METER READING		TOTAL WATER (Cu. Ft.)	C. F. M.
TOP DEPTH	BOTTOM DEPTH		START	END	INTERVAL (Min.-Sec.)	START OF TEST	END OF TEST		
Single Packer									
60.0	92.5	5	0923	0928	5 min.	896.50	896.50	0.00	0.00
Double Packer									
60.0	54.7	5	1000	1005	5 min.	896.98	896.98	0.00	0.00
55.0	49.7	5	1008	1013	5 min.	897.04	897.04	0.00	0.00
50.0	44.7	5	1015	1020	5 min.	897.13	897.13	0.00	0.00
45.0	39.7	5	1023	1028	5 min.	897.20	897.20	0.00	0.00
40.0	34.7	5	1031	1036	5 min.	897.50	898.02	0.52	0.10
35.0	29.7	5	1040	1045	5 min.	898.25	898.92	0.67	0.13
30.0	24.7	5	1048	1053	5 min.	899.25	899.96	0.71	0.14

PROJECT	BORING NO.	INSPECTOR	DATE
STONEWALL JACKSON DAM	GC-8	DAVID NUGEN	6-2-8[illegible]

ORH FORM 2142
1 DEC 68 (HED Pam 1110.1.1)

SUBSURFACE EXPLORATION
PRESSURE TEST DATA

BORING SIZE	ELEVATION TOP OF HOLE	ELEVATION TOP OF ROCK	STATIC WATER LEVEL
3 IN. (NX)	1102.0	1082.0	N/A

PUMP CAPACITY	METER TYPE	METER SERIAL NUMBER
22.9 G.P.M.	BUFFALO METER COMPANY	6547826

FIELD TEST DATA

TEST SECTION		GAUGE READING (P.S.I.)	TIME OF TEST			METER READING		TOTAL WATER (Cu. Ft.)	C. F. M.
TOP DEPTH	BOTTOM DEPTH		START	END	INTERVAL (Min.-Sec.)	START OF TEST	END OF TEST		
Single Packer									
60.0	92.5	5	0923	0928	5 min.	896.50	896.50	0.00	0.00
Double Packer									
60.0	54.7	5	1000	1005	5 min.	896.98	896.98	0.00	0.00
55.0	49.7	5	1008	1013	5 min.	897.04	897.04	0.00	0.00
50.0	44.7	5	1015	1020	5 min.	897.13	897.13	0.00	0.00
45.0	39.7	5	1023	1028	5 min.	897.20	897.20	0.00	0.00
40.0	34.7	5	1031	1036	5 min.	897.50	898.02	0.52	0.10
35.0	29.7	5	1040	1045	5 min.	898.25	898.92	0.67	0.13
30.0	24.7	5	1048	1053	5 min.	899.25	899.96	0.71	0.14

PROJECT	BORING NO.	INSPECTOR	DATE
STONEWALL JACKSON DAM	GC-8	DAVID NUGEN	6-2-86

ORH FORM 2142 (NED Pam 1110.1.1)
1 DEC 68

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